THE AMATEUR MECHANIC

THE AMATEUR MECHANIC

A PRACTICAL GUIDE FOR THE HANDYMAN

EDITED BY

BERNARD E. JONES

EDITOR OF "WORK"

NEW, ENLARGED EDITION REARRANGED AND ENTIRELY RESET

With Thousands of Photographs and Drawings

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Contents

Picture Mounting, Framing and Hanging

Mounting Almanacs and Presentation Plates.—An almanac or presentation plate is often improved by cutting off the margins and mounting it on a white cardboard mount. Engravings and pictures of value should never be interfered with in this respect, but should be mounted just as they are; to cut away the white, the signature, etc., would detract from the value of the picture. Place the picture to be mounted face side down on a clean sheet of paper (or the under-side of a mount), and with a clean brush give it a coat of good flour paste;

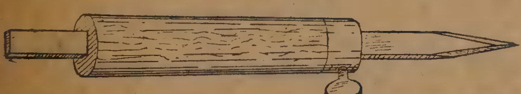


Fig. 1.—Mount-cutter's Knife

now let it stand five or ten minutes to allow the paste to sink well in. Then give it another coat of paste, and if it is perfectly soft and lies down quite flat without an inclination to curl up, it is ready for being mounted. Pick it up carefully to avoid tearing, and place it in position on the mount; cover it with a sheet of clean paper, and, working from the centre with a duster, rub it carefully down until air-bubbles and wrinkles disappear. If a little paste has oozed on to the edges of the mount, carefully wipe it away with a sponge and clean water. Now put the picture to dry under another mount or a sheet of cardboard, and place a few books or weights on it to keep it flat.

Mounting Pictures on Calico.—Large pictures are often mounted on calico, which is stretched and tacked down on a flat board or table-top, and the picture is then mounted on the calico precisely the same as on cardboard. When perfectly dry the calico is tacked on to a flat frame of wood.

Stretching Pictures.—A method of

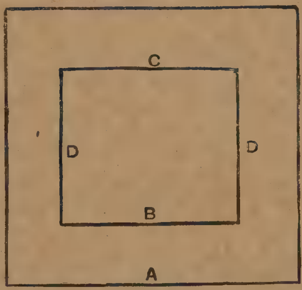


Fig. 2.—Setting Out a Rectangular Mount

mounting, or stretching, large pictures is to mitre together a flat wooden frame of the size required for the picture. Lay the picture face down on a table-top, and evenly damp it with a sponge and water until it is perfectly flat and pliable. Then glue all round the face edge of the frame, place the frame on the back of the picture, and see that the frame touches the picture closely all round. Allow it to dry evenly and slowly without heat in a horizontal position, and the result will be that it

will be stretched tight without wrinkles. The principle is that the water expands the paper, and that it is tightly held by the edges during the subsequent drying and shrinking.

Sunk Mounts.—Pictures are often much improved by what are called sunk mounts. The picture is first mounted in the usual way, and then a second mount is cut with an opening in it, to reveal as much of the picture as is thought necessary. This is placed in position over the first mount, and the two are fastened together. Sunk mounts are usually cut from cardboards known in the trade as "fine mounting boards"; the most usual substance for the work is "eight-sheet," though very large mounts are often cut from much thicker stuff.

Fig. 3.—Using the Mount-cutter's Knife

The various names and sizes of the trimmed boards are as follows: Royal, 24 in. by 19 in.; Imperial, 30 in. by 21 in. or 22 in.; Atlas, 33 in. by 26 in.; Double Elephant, 39 in. by 26 in.; Double Imperial, 43 in. by 29 in.; Antiquarian, 53 in. by 35 in.

The tools, etc., that the worker will require for mount cutting are: a knife, steel bevel, deal board, compasses, rubber, oilstone, wooden straightedge, T-square, and a 2-ft. rule.

The knife is specially made for mount cutters, and has a stout brass-bound handle fitted with a movable steel blade, which can be adjusted at will (see Fig. 1). The wooden straightedge should be fully 32 in. long, so as to take the length of the Imperial board; the compasses must be 8 in. or 10 in. long.

Setting Out Rectangular Mounts.—Fig. 2 represents the method of setting out a rectangular mount. The lower edge of the mounting-board A having been cut perfectly straight, mark off the nearest parallel cut B, and distant from it the width of the required opening mark a second line C. The T-square, placed against the trimmed edge A, will then give the perpendiculars D D and determine the length. When severing the card, the deal board is placed so that the pressure comes as near as possible along its centre, and it is usual to lay a strip of pasteboard between the board's surface and the mount; this forms a suitable material to protect the thin blade when it comes through the mount, and prevents the ragged edge on a bevel which results from cutting on bare wood.

Cutting a Mount.—In cutting out the opening, the straightedge is held firmly with the left hand while the board is cut through with the knife held on the slant (see Fig. 3). After the middle has been removed from a cut-out mount, it should have a clean bevel entirely free from raggedness, but to ensure this, it is necessary to keep the knife in thorough working order. Only moderate pressure should be used, and the knife should be carried always at the same angle to the

straightedge. The slight roughness which is always found at each corner after the middle of a mount is removed may be easily taken away with the knife, the mount being held flat on a piece of cardboard. When a very deep mount is required, the cutter uses correspondingly stouter boards, but it should be remembered, however, that the depth of a mount can be made to appear much greater by simply cutting the bevel wider.

Oval Sunk Mounts.—Oval mounts are set out as follows: By means of a straightedge find the middle A (Fig. 4), mark off half the length of the opening required, which is A B; place the **T**-square on the bottom edge of the cardboard, and produce the line A C, half the width of the opening. Open the compasses the length of line A B, place one leg at C, and the other, cutting the line D B, will indicate the position where needles should be inserted. To strike the oval line, a piece of cotton is passed over the needles and tied so slack that a pencil pressing outwards and guided round by the cotton will trace the ellipse.

No guide whatever is employed in cutting an oval mount, its uniform bevel depending entirely on the hand and eye of the operator. It is preferable to use a shorter blade in cutting oval mounts than in rectangular ones, especially when the ovals are small and narrow. Though length of blade may give the necessary freedom in the sweep of a large oval, it is unsuited to small, sharp curves; furthermore, a short knife admits of the arm resting nearer the work, and thus checks any tendency to unsteadiness. A mounting-board that is not much thicker than eight-sheet should be severed with one cut, as it will be almost inpossible to pass round a second time without injuring the bevel. It is also necessary to hold the knife precisely at the same angle the whole time that it is traversing the oval.

Gilt-binding a Mount.—For binding a mount, the best quality gilt paper may be bought ready gummed. Or the paper may be prepared by coating it with a solution of gum arabic, rapidly and evenly applied with a camel-hair brush. To bind a mount, cut a sufficient quantity of the gummed paper into narrow strips, and select a piece about $\frac{1}{16}$ in. longer than the length of the side in hand; place it gilt side down on a clean paper, and wet it with weak gum. Hold the mount in a vertical position with the left hand, and take the gilt paper between finger and thumb of the right hand and rapidly lay it on. Care must be taken to keep the fingers free from gum, as once this gets upon the gilt surface, it is impossible to remove it without spoiling the gold. In binding oval mounts, it will be found essential to notch that edge of the paper which turns under; the smaller the opening the closer together must the cuts be.

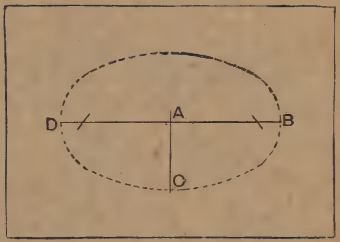


Fig. 4.—Setting-out an Oval Mount

Gilding Mount Edges.—Instead of binding the mounts with gold paper, the edges may be gilt with gold-leaf as follows: Secure the mount in position by any suitable contrivance. A red earthy substance called bole is mixed with blacklead, and applied over the edge with a wet sponge. The edge is then brushed over with a hard brush until it is perfectly dry and shining. The size used is composed of 1 part of white of egg and 7 parts of water. Sufficient gold-leaf to cover the edge is taken out of the book and carefully laid upon the cushion, blown out straight, and cut with a knife to size; each piece of gold is taken from the cushion and laid upon a broad piece of paper which has been previously passed over the hair of the head. Having done this, apply the size to the mount's edge with a flat camel-hair brush, and while the size is wet take up one of the slips of paper with the gold-leaf adhering to it, and carefully transfer the

gold to the edge. When almost dry, which will not be very soon, place on the gold edge a piece of smooth, stout paper, and rub over with the burnisher. The edge should now have a dull appearance, and any holes that appear should be made good by cutting small pieces of gold and lifting them from the cushion with a small pad of cotton-wool and breathing on the place to be mended, the gold being afterwards pressed on with cotton-wool. The edge should be again rubbed down and left to dry, when it should be burnished. The burnisher is held in a convenient position in the hand at an angle of 45° to the mount's edge, and pressure is applied from the shoulders.

Matt-gilding Mounts.—For water-colours and certain styles of coloured prints, a mount or surround of matt gold is eminently suitable. Mounts may be prepared for matt gilding by giving them one or two coats of patent knotting thinned slightly with methylated spirit; the knotting may be used without any addition if fresh and free working. It should be followed by at least four coats of matt size, and the actual gilding may then begin, as described in the next paragraph but one.

A more satisfactory method of preparing a mount for gilding, but involving more time, is to body up with gilder's whiting and clear parchment or gelatine size used hot, lightly glasspapering between the coats. Give two or three coats, and polish by wetting and rubbing with a wad of calico. Then give four coats of matt size, polishing again if necessary. The surface must be as smooth as a piece of marble or glass to produce a good matt.

To lay a matt, begin at the left-hand corner. With clear water damp a part from corner to corner, left to right, using a camel-hair mop, and lay the leaf while the surface is wet. This must be damp enough to cause the leaf to sink and stretch out to its utmost capacity, presenting a smooth surface, as all wrinkles will show holes when the dry gilded surface is rubbed or polished with cotton-wool. Lay the leaf from left to right, and keep the surface below wet, so that when laying the second row there will be little fear of bad joins showing. Faults where leaves split or break in laying should be covered as the work proceeds. When the mount is covered and the gold is dry, lightly polish with cotton-wool.

If in good condition, the gold is ready for coating with ormolu size (see Index); but more likely it will need "faulting"—that is, covering bad places or joints with narrow strips of leaf. For best work apply a second layer of gold, damping with warm, weak size and gilding as before. Polish when dry, and coat with clear size.

Gold-lining Mounts.—Dissolve gum arabic in just enough water to effect solution, add a little moist sugar, and strain through muslin. Try it in a quill pen, and if it is too thick add water. Rule the lines with the gum and quill pen (or draughtsman's ruling pen), allow them a few minutes to get "tacky," and then apply strips of gold leaf (for full instructions on gilding see an earlier chapter). When dry, brush off the gold where it is not required. Instead of gold leaf, "gold" bronze powder or silver or aluminium bronze powders may be dabbed on the gum-lines, first allowing these to set, and then breathing on them before applying the powder. The "gold" bronze will soon tarnish.

White-lining Mounts.—There is no better method of white-lining mounts than to use Chinese white or similar pigment mixed in a little water and applied by means of a draughtsman's ruling pen; an ordinary pen will also answer, but the thickness of the lines is liable to vary, and the pen cannot hold much at a time.

FRAME-MAKING

Picture frame-making if confined to work in solid mouldings, is by no means difficult, but it is one of the most useful arts that the handicraftsman can master. The tools are few, the material not expensive, and the product of the labour is of great domestic utility.

Mouldings.—Mouldings in great variety are obtainable, the veneered stuff being far inferior to the solid. Oak mouldings are made in a variety of patterns; some

are plain, as in Fig. 5; some with bead and scotia (Fig. 6); some with bead, fillet and chamfer (Fig. 7); while the reeded section shown in Fig. 8 is fairly

Fig. 5

Fig. 6

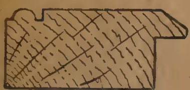


Fig. 7

Fig. 8

Figs. 5 to 8.—Sections of Various Patterns of Oak Mouldings

common. Spoon mouldings (Figs. 9 and 10) look well when made up.

For use principally with oak frames, gilt slips may be bought cheaply. For the smaller frames $\frac{1}{2}$-in. square-edged slips (Fig. 11) will be suitable; for larger frames $\frac{3}{4}$-in. to 1-in. slips, with bevelled edges (Fig. 12), may be used. Less common than the gilt slips are plain slips of sycamore, walnut, etc.

Ornamental mouldings of diverse patterns and various materials can be bought, but the tendency at present is distinctly towards simplicity, for which reason plain wood frames remain very popular. Compo. mouldings for gilding are sold in lengths, and the corners often need to be covered with ornaments to hide defective joints.

Tools.—The tools include a small tenon saw, a jack plane or a trying plane, two or three chisels and bradawls, and, if desired, some form of cramp. For guiding the saw in cutting the mitres, either a mitre-block or a mitre-box is indispensable; and a mitre-shoot for finishing the mitres will also be required. Mitre-cutting machines and patent corner cramps are obtainable in great variety, but the practical man does better without them.

Mitre-block.—The mitre-block is not so popular as the mitre-box; it consists of two of pieces of wood the shape indicated in Fig. 13 (or of a solid block rebated to the shape shown); the dimensions may be made to suit convenience. The narrow piece is screwed to the broad piece, the ends trued, and two mitre lines set out by means of a bevel gauge. With a tenon saw in first-class condition, cut down through the top piece on the mitre lines. In use, the moulding to be cut is held firmly in the rebate of the block, and the groove in the block serves to guide the saw, as illustrated photographically by Figs. 14 and 15. The amateur quite fresh to woodworking should not attempt to make either a mitre-block or mitre-box, since any inaccuracy in setting out and sawing the mitres will be reproduced on every piece of moulding cut with the aid of the device; they are very moderate in price, and may be obtained from a tool dealer's.

Mitre-box.—The mitre-box (Fig. 16) consists of three pieces of wood, each 18 in. long by $2\frac{1}{4}$ in. wide (for narrow mouldings) and $\frac{3}{4}$ in. or 1 in. thick, nailed together to form a trough. In getting out the bottom piece, great care must be taken to keep it parallel and to plane the edges square. Two saw cuts are made in the sides; these are at right angles with each other, and at angles of 45° with the side of the mitre-box, as clearly shown in the illustration.

The mitre-box is used in practically the same way as the mitre-block (see Fig. 17).

Mitre-shoot.—A mitre-shoot for picture framing may be the simple contrivance shown in Fig. 18. Obtain a level

Fig. 9

Fig. 11

Fig. 10

Fig. 12

Figs. 9 and 10.—Sections of Spoon Mouldings

Figs. 11 and 12.—Sections of Gilt Slips

board A about $\frac{3}{4}$ in. thick with one edge straight, and on this nail a strip of wood B (the fence) at an angle of 45° with the straight edge. Setting out the angle is a

simple matter if a bevel or set-square is used. A more convenient mitre-shoot is shown by Fig. 25 (p. 9); this has a baseboard as before, but instead of a strip the fence is a triangular piece of wood screwed

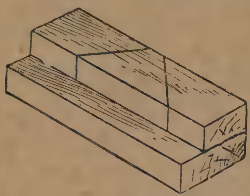


Fig. 13.—Mitre-block

upon it. The purpose of the board shown to the right in Fig. 25 is to raise the moulding, after some amount of work has been done, so as to bring another part of the edge of the cutting iron into use, thus distributing the wear over the whole edge. The work-bench itself may easily be fitted up temporarily as a shooting board (see Figs. 19 and 20). The plan shows the method of setting the fences by the aid of the 45° set-square.

Figs. 14 and 15.—Cutting Mitres in Mitre Block

The slide for the trying plane or jack plane, whichever is used, is made from a piece of 3-in. quartering about 2 ft. long. True up the top face, and bore three or four holes for extra large wood screws, or $\frac{3}{8}$-in. coach bolts. Fix the slide $\frac{1}{2}$ in. below the top edge of the bench, and $\frac{1}{4}$ in. away, by inserting two or more short packing strips between the bend and the quartering. The space thus formed enables the shavings and chips to drop

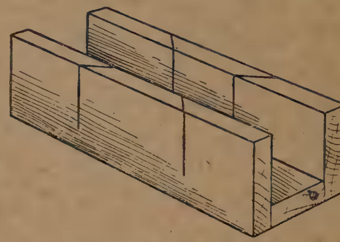


Fig. 16.—Mitre-box

clear away without getting under the plane and throwing it out of square. The top face of the slide should be parallel with the top of the bench, when measured by rule or callipers between the projecting end of a straightedge laid on the top of the bench. The packing pieces can be planed on the top or bottom face as necessary, to effect the adjustment. This done, cut two pieces of 2-in. by 1-in. batten 10 in. long. Clean up the bottom face and one edge of each piece, and bore and countersink holes for stout screws 2 in. long. Next pencil a line on the bench with a try-square. Then midway between

the ends of the quartering or slide, hold the plane firmly against the edge of the bench, place the 45° set-square about

Fig. 17.—Cutting Mitre in Mitre-box

$\frac{1}{2}$ in. away from the centre line, and then pencil a line on the bench on the 45° edge of the square. The planed edge of the batten should coincide with this line. Place the gimlet or bit through the holes in the battens to mark them on the bench,

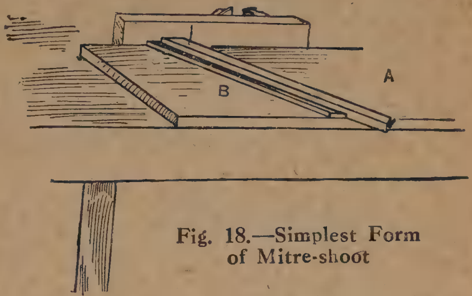


Fig. 18.—Simplest Form of Mitre-shoot

bore them with a smaller gimlet, and fix the batten with screws. Try the fence thus made with the set-square, as shown at Fig. 20. If the batten has shifted whilst screwing down, it should be removed and the edge adjusted with a smoothing plane. Cut the front end of the fence exactly over the centre line

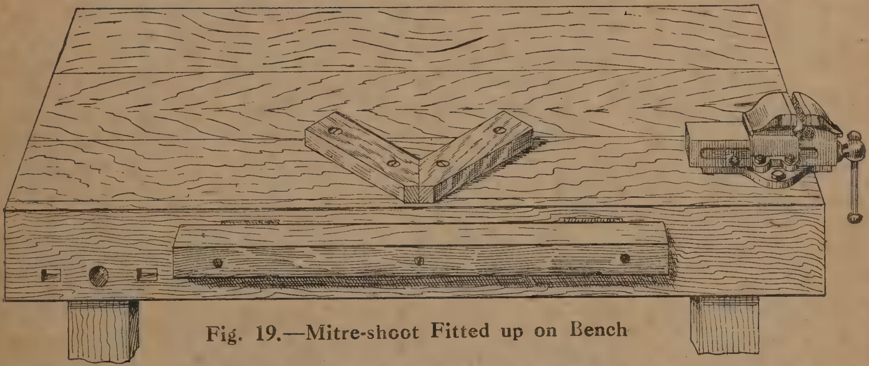


Fig. 19.—Mitre-shoot Fitted up on Bench

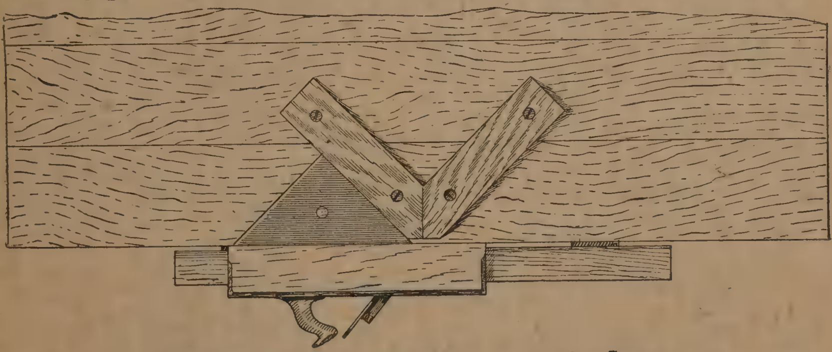


Fig. 20.—Setting Fence of Mitre-shoot with Set-square

previously marked on the bench, shape the second fence in a similar manner, and fix and adjust it as described for the first batten.

Marking off and Sawing Mitres.—

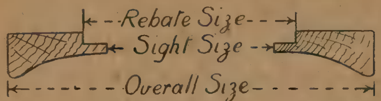


Fig. 21.—The Three "Sizes" of a Frame

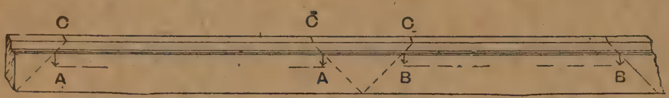


Fig. 22.—Marking Piece of Moulding for Cutting-up

A picture frame has three sizes (see Fig. 21) —(1) overall, (2) glass, picture, or rebate size, and (3) the sight size. Determine the picture size, and mark off the length and width on the moulding inside the rebate (see Fig. 22), and, putting the moulding in the mitre-block, cut the mitres at the marks. It will be found that two lengths of moulding will generally make three medium-sized frames, or one fairly large and two small frames. To effect this it will sometimes be necessary

Fig. 23.—Cutting Mitre by Means of Bevel

to cut the lengths for one frame from two lengths of moulding, using up the short pieces for the sides or for making up smaller frames. This is one of the reasons why frame-making pays better when several are done at once. If the frames are being made of painted or enamelled material, the mitres must be cut from the face side of the moulding, or the saw will break up the surface and chip the enamel.

Should the worker wish to dispense with the use of mitre-box or block, space out the measurements between the mitre lines and next to the rebated edge, as shown at A and B (Fig. 22). After marking the mitre lines with the bevel gauge set at 45°, the lines should be projected on the front edge of the moulding as shown at C, so as to indicate the position for the saw cut. The moulding is next gripped in the vice by the rebate and outer edge, and face uppermost. The bevel gauge is then brought up to the line C, and is held firmly against the moulding while the tenon saw starts the cut as shown at Fig. 23.

Shooting the Mitres.—When the mitres of the four pieces to form the frame have all been cut, place the mitre-shoot on a bench or table, put the moulding in the mitre-shoot, and, holding it with the left hand, work the plane with the right hand to clean up the mitre (see Figs. 24 and 25). Care must be taken that the cutting-iron is sharp, and set true and square. When the first mitre is shot, turn the piece of moulding, end for end, and shoot the other end. Repeat the processes on the remaining lengths of the moulding until all the mitres have been planed. Try the opposite pieces of the frame by putting them edge to edge, to make sure that they are of the same length. If not true in this respect, a few strokes with the plane will rectify them. Another method of testing is to lay them on the bench on their outer edges close together, and then to hold the stock of the try-square on one pair of mitres and compare the opposite ends of moulding, reducing, if necessary, till of the same length. If a jack plane is used, care should be taken to see

that the iron is not ground too "rounding," as this will make the mitres too hollow, and with thin moulding, out of square. The effect of working with a rounding iron is shown (exaggerated) in the sectional view Fig. 26.

Fig. 24.—Shooting a Mitre

The beginner occasionally meets with considerable difficulty in cutting the mitres true and making good square joints; but the trouble disappears with experience, providing that care is taken to see that the iron of the shooting plane has a really keen edge. Only the lightest possible cuts should be taken off at each stroke of the plane, or any composition on the frame will be damaged, this being of a hard or brittle nature, and quickly taking the keen edge off the cutting irons. When operating on hollow-back or irregular-edge moulding, either on a shooting board or in a special trimming machine, suitably shaped blocks of wood should be inserted between the moulding and the guides or fences, so as to form additional support to the moulding, otherwise the thrust of the cutting iron will invariably either tip over or crush the narrow edge of the moulding next to the guide or support.

Of late years professional woodworkers have taken more and more to the use of the machine trimmer, and even the amateur with much work to do would find one of the smaller machines a convenience that would pay for itself.

No trimmer will do its work properly unless the cutting edge be kept extremely keen. Of the many trimmers that have been put on the market, the simplest have a pull-over lever knife, the exact angle of the mitre being controlled by adjustable fences.

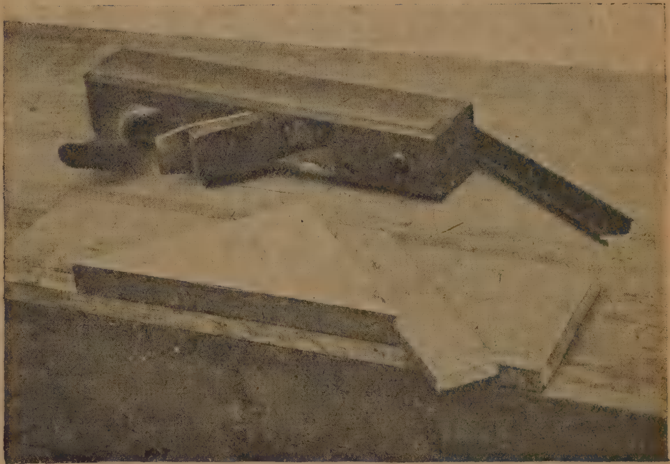


Fig. 25.—Mitre-shoot with Extra Board, etc.

Jointing.—Gluing up is the next operation. The glue should be freshly made and not be thick, and the frame should be put together in a warm room, or the glue will become chilled before the surfaces are united. There are two systems

of working; in one, the joints are glued and nailed in one operation, and cramps are not required. This is the professional's method, and is the better of the two. but

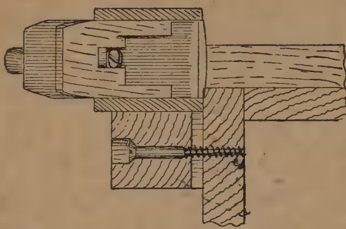
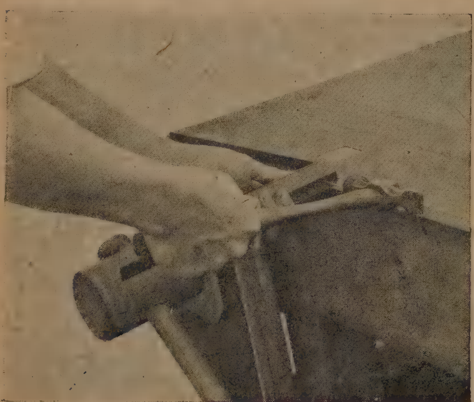


Fig. 26.—Effect (Exaggerated) of Shooting Mitre with a "Rounding" Iron

it requires an amount of dexterity which the amateur does not always possess. In the other method, the joints are glued, the frame cramped until dry, and the joints then strengthened with nails, screws, or in any other way preferred. These methods will be described here in the order given. If taking up framing in a large way, the quicker plan will be to dispense with cramps, which, after all, are of service only on square-edge mouldings.

First Method.—Place a piece of moulding in the vice, the moulding being gripped by its back edge and the edge of the rebate; then screw up the vice as tightly as possible without injuring the moulding. Next take up a side or end of the frame, as the case may be, and try the mitres together. Slide the piece about $\frac{1}{8}$ in. towards the back edge, and bore carefully one or two holes with a sprig-bit or fine bradawl right through one piece and a little way into the other. Insert the brads or nails with the fingers, smear the mitred surface of the loose piece with hot glue, replace in position, and drive in the brads (see Fig. 27). See that the lines of the mouldings intersect correctly. This may seem difficult, but it is surprising how easy it becomes after a little practice. One-half of the frame has now been made. Next make another half in exactly the same way, and, leaving it in the vice, join on the other half by the same method (see Fig. 28). For making the fourth joint it will be necessary to shift the work in the vice. The brads should be punched just below the surface, and the holes filled in with coloured putty.

Second Method.—Having cut the sides and shot the mitres, put the frame together on the bench or table, place at each corner a block shaped as in Fig. 29, and tie on the strings as shown by Fig. 30. To pull the corners up tightly, put small pieces of lath between the strings and then twist them. Sometimes the mitres will come slightly out through one or more of the mouldings not being quite straight; but this may be remedied by putting a small chip of wood between moulding and fence



Figs. 27 and 28.—Nailing Together Picture Frame

when shooting the mitre. If all is right, proceed with the jointing. The string and corner-blocks are left on the frame, but the cord is loosened, and the mould-

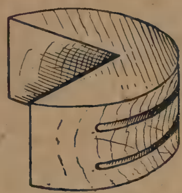


Fig. 29.—Corner Block for Picture Frame Cramp

ings lifted one after the other while just a thin coating of glue is brushed over the mitres. Pieces of paper should be placed under the corners to prevent the glue adhering to bench or table. The work should be done as quickly as possible, and the frame cramped up tightly and placed on one side for a day to dry. Then the corners should be strengthened with nails, screws, slips of veneer, or in one or the other ways fully illustrated and described on a later page.

The cramp above described is not the only one possible. The same idea is exemplified in Figs. 31 and 32. As before, hardwood corner pieces are made and grooved for the tightening line, for which blind cord is suitable. The corner pieces are not essential on plain edge mouldings, as several thicknesses of brown paper placed at the angles will be sufficient to protect the cord from chafing. They will, however, be required of special shape on florentine mouldings, or on those shaped like the one shown at Fig. 33. In this case, the blocks may be of soft pine and made the same contour as the moulding; a little cotton-wool may be inserted at the angle to prevent injury to delicate florentine mouldings. The cramping lever or strainer consists of a piece of stuff (hardwood for choice) about 9 in. long, $1\frac{3}{4}$ in. wide, by 1 in. thick, in which are driven two $\frac{1}{4}$-in. diameter metal pegs $2\frac{1}{2}$ in. long and spaced about $\frac{3}{4}$ in. apart. Extra holes are provided on each end to receive the stop peg. The cord is passed around the frame, which is laid on the bench or table, and the metal pegs of the strainer are dropped over the cord and twisted till the cord is sufficiently taut. The peg to retain it in this position is then dropped in the nearest hole (see Figs. 31 and 32). Should either of the mitre joints spring out of place during the straining up, a weighted board should be placed over that particular angle.

A cramp of a different kind is shown by Fig. 34. The hardwood bars are $1\frac{3}{4}$ in. by $\frac{3}{4}$ in. The corner pieces or catches can be adjusted along the bars, and are arranged to turn on a small bolt, so as to meet any size frame. The centre pieces are 7 in. long and 2 in. by $1\frac{1}{4}$ in., and are fixed to the bars with bolts, there being freedom of movement to adjust the cramp to different sizes of frames. The frame is placed on the cramp as indicated by the dotted lines, and the corner pieces are then slowly pulled in by means of the steel cramp which works in the two centre pieces.

It is advisable to adopt some additional means of securing the glued joints.

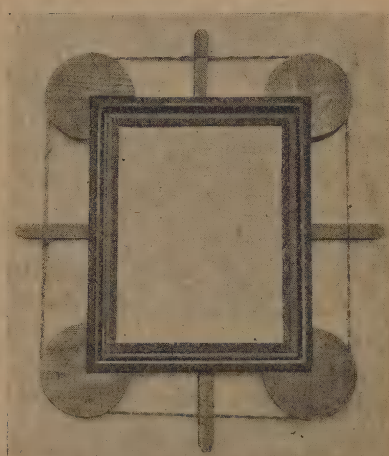


Fig. 30.—Picture Frame in String Cramp

(*a*) Two oval-section wire nails may be driven in. Grip the angle of the frame with the rebate resting against the side of the vice jaws (see Fig. 35), and the frame will then be supported better for the nailing up of the joints.

(*b*) A screw may be used, as in Fig. 36, the head being sunk below the surface by first boring a hole with a centre-bit; afterwards the whole may be filled with coloured stopping or with a wood plug.

(*c*) One of the simplest methods is to glue slips of wood, about $\frac{1}{8}$ in. thick, across

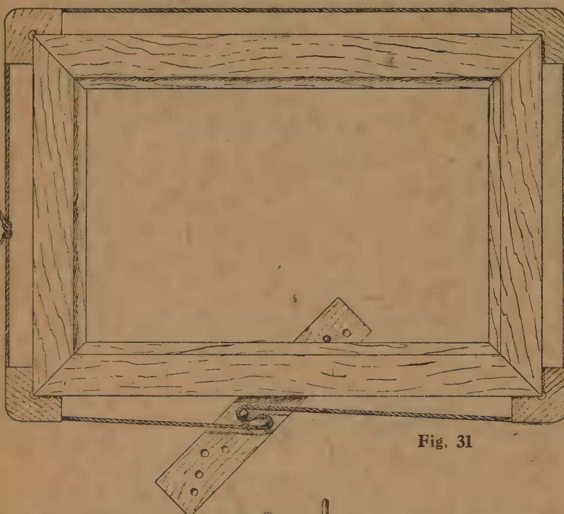


Fig. 31

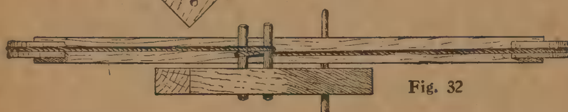


Fig. 32

Figs. 31 and 32.—String Cramp with Pegged Strainer

the joint, further securing the slips with small sprigs or screws, as in Fig. 37. Or brass plates may be screwed on across the mitre.

(*d*) A good method is to run one or two saw kerfs into the corner as at A (Fig. 38), and to glue in pieces of veneer as at B.

(*e*) A keyed joint may be formed as in Fig. 39. A dovetail channel is worked out across each mitre, and a key-piece driven in, glued, and cleaned off flush with the back and edges of the frame. The joint may be still further strengthened by adopting method (*d*) in addition.

The following methods of strengthening demand special shaping of the joints before gluing up.

(*f*) Fig. 40 is an improvement on the mitred joint. The mitres are shot by the same method, and a square piece of hardwood $\frac{1}{4}$ in. thick mortised in to strengthen the corner.

(*g*) The mitre bridle joint is shown by Fig. 41. With this joint one end cannot be shot, but the shoulder is sawn and finished off with the chisel.

(*h*) A better and stronger kind of mitre

Fig. 33.—Corner Block Used in Cramping Fancy Mouldings

bridle joint is shown by Fig. 42. The square shoulder at the back allows room for two screws at each joint (see Fig. 43).

When halved joints are employed, the wooden bench-vice can be used as a cramping device in conjunction with a batten E (Fig. 44) screwed to the bench. A block D is screwed to the tangs, and the frame F lies on the bench between a packing strip G and the batten E.

The glued-up frame should finally be cleaned off at the

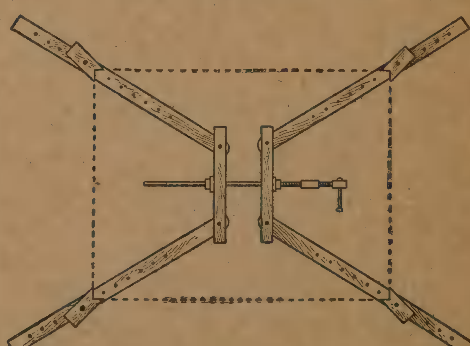


Fig. 34.—Screw Cramp for Picture Frames

back with a smoothing-plane, and, if required, scraped and glasspapered all over.

Slips.—The next job will be the fitting of the slips, if these are required. They

are mitred similarly to the frame. Care must be taken not to spring them into the frame too tightly, or the gilt will chip off at the corners. It is advisable to place the slips inside the glass if possible, thus protecting the gold from atmospheric action, fly-marks, etc., but in some cases it will be necessary to put them outside. In taking out the slips, lift one of the longest pieces at the centre.

The Glass.—The novice at cutting glass should practise on waste pieces, and note carefully the position in which the diamond cuts best (never going over the same cut twice). In using the diamond, still more so in using a wheel glass-cutter, seek to give a uniform pressure, as otherwise the glass may be cracked, possibly at right angles to the line of cut required. The glass should bed well upon a level surface (say a couple of newspapers on a table-top), and if much cutting is to be done a baize-covered table should be employed. Always have the glass a trifle

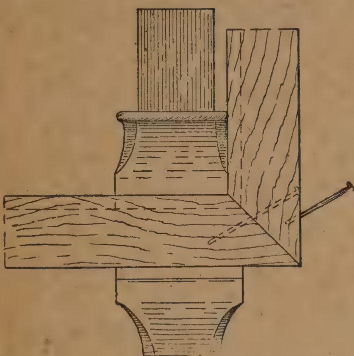


Fig. 35.—Nailed Joint of Frame

Fig. 36.—Screwed Joint of Frame

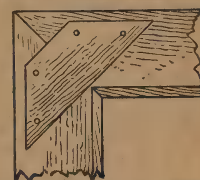


Fig. 37.—Joint Strengthened with Slip of Wood

Fig. 40.—Square Piece of Wood Mortised into Mitre Joint

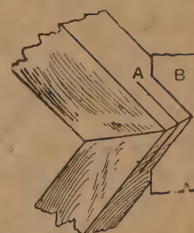


Fig. 38.—Joint Strengthened with Glued-in Veneer

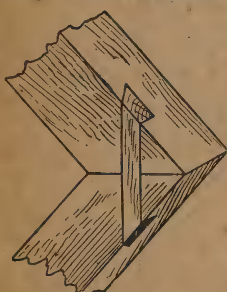


Fig. 39.—Keyed Joint of Frame

Fig. 45.—Section of Fitted Frame Showing Bevelled Backboard

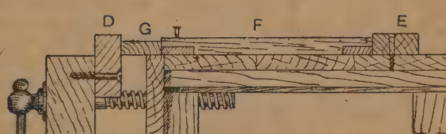


Fig. 44.—Using Bench Vice as Frame Cramp

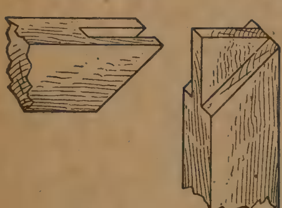


Fig. 41.—Mitre Bridle Joint

Figs. 42 and 43.—Square-shoulder Mitre Bridle Joint

smaller than the rebate size of the frame, otherwise with expansion due to the proximity of a lamp, the glass is liable to crack.

The glass should be thoroughly cleaned, and this work is best done with a cloth and some methylated spirit, the latter assisting in the production of a good polish on the glass and drying almost immediately.

The Backboard.—Backboards for the frame may be bought from the dealers at so much per "plank," this usually consisting of a piece of pine 6 ft. by 12 in. by 3 in. cut into thin boards, the number of which varies according to the thickness. Thin backboards can easily be cut to the required size with a chisel, using a rule as a guide, and drawing the chisel along in the same way as a diamond; the board will then break clean through the chisel cut. Or a sharp pocket-knife will answer. Stouter boards must be cut with a fine tenon saw. On large frames extra thick backing should be used, the best being two-ply, which does not warp. In cases where the glass, picture and, backboard nearly fill the depth of the frame, as in Fig. 45, the edges of the backboard should be bevelled, as shown, for convenience in inserting the sprigs. In other cases, it is better not to bevel the edges.

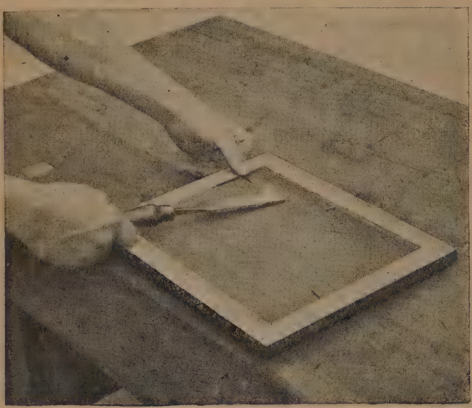


Fig. 46.—Driving Picture Frame Sprigs with Old Chisel

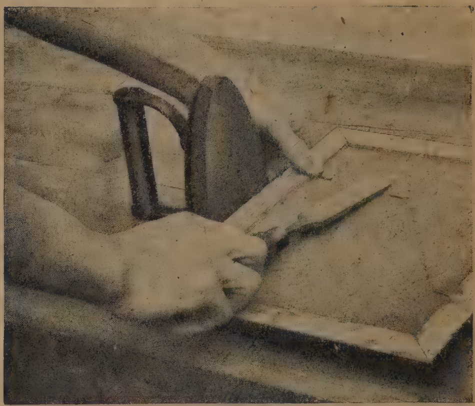


Fig. 47.—Holding Frame Against Heavy Weight, when Driving Sprigs

Fitting up a Frame.—The glass, picture, and backboard being in position, they are secured so by driving in headless brads ("sprigs"). Some framers fear to use the hammer, and they push in the sprigs with a pair of pliers, care being taken not to make the sprigs bind too tightly on the back, or the glass may break. But the risk in using the hammer is small if proper care is taken; though the hammer needs to be one with its original edges unimpaired. The use of an old, heavy chisel, held as in Fig. 46, instead of a hammer, has been found of some advantage. Small frames should be held against a weight, such as a flat-iron (see Fig. 47), and the insertion of the sprigs is then a much easier matter, and does not tend to weaken the mitred joints.

At first, put in only sufficient sprigs to hold in the back, and then examine to see that there is no dust, etc., between the picture and the glass. If satisfactory, insert the rest of the sprigs.

As a preventive of dust, smoke, and to some extent of damp, after the glass is in the rebate, strips of paper about $\frac{3}{4}$ in. wide may be glued in round the rebate in such a way, of course, that they do not show from the front. The back of the frame is covered with strong brown paper. Then, when the backing sprigs are in, wider strips of brown paper may be glued or pasted in round the rebate and over the joints (if any) in the back-

board. To give a tidy appearance, it is well to cover the back of the frame with one piece of brown paper. To affix this, damp it with a sponge and water, apply glue to the back of the frame moulding, place the paper in position, and rub well down where glued; trim off the surplus paper with a sharp chisel or knife, and it will dry as tight as a drum. Good, stiff paste may replace the glue.

All that remains to be done now is to insert the screw eyes (first boring holes with a fine bradawl), taking care, in the case of thin frames, not to screw them right through. Those with loose rings are the best. Generally, the rings are best placed on the back of the frame; they

Fig. 48.—Picture-frame Joints and the Means of Strengthening Them

are not ornamental, and it is a mistake to screw them into the top edge when that course is avoidable. The higher up on the back the rings are placed the less will the frame incline from the wall.

Oak frames are sometimes polished or varnished, but they are preferably left in the natural wood. A good effect may be obtained in some cases by treating with a little walnut stain to give the appearance of old oak. Plain oak frames will keep clean a long time if rubbed up with fine glasspaper and polished with a handful of shavings. Waxing, too, gives a pleasing effect. Recipes for the making of picture-frame stains are given on another page of this series of volumes.

STRENGTHENING LOOSE FRAME JOINTS

Picture-frames, especially the cheaper kinds, sometimes develop a looseness at

Figs. 49 and 50.—Suspending Picture by Means of Chains

the corners, due to bad mitreing, decay of the glue, or unsatisfactory nailing. If the moulding is narrow or of composition it is a risky thing to attempt re-nailing

Fig. 51.—Single Wire Looped to Pass Over Hook

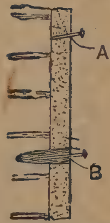
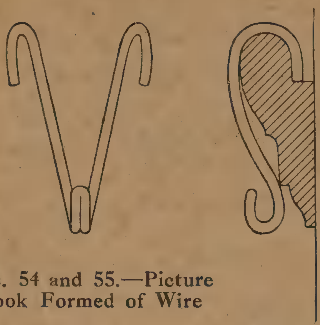


Fig. 52.—Nails in Wall

Fig. 53.—Picture Hook in Lath-and-plaster Wall

the corners. It is better to obtain four brass angle-plates of suitable size, and to screw these at the back of the frame, as shown at A (Fig. 48). This makes a

strong and efficient repair, invisible from the front. Another way, suitable for small frames, is to lay the frame face down



Figs. 54 and 55.—Picture Hook Formed of Wire

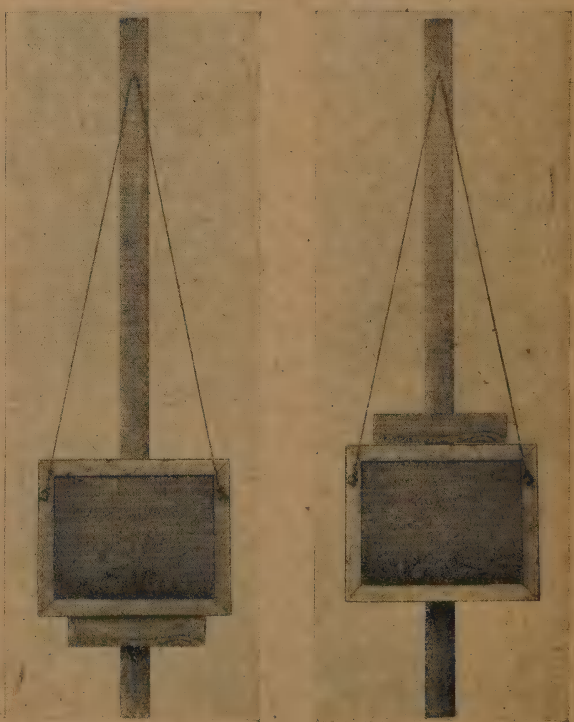
on several layers of cloth, so as not to damage the front, and to knock in short, pointed iron or wire cramps, of the kind shown at B, across the mitres, as shown at C. This should be done gently with a light hammer. A little melted glue may then be rubbed into the joint, if that does not meet perfectly, by means of a hard brush.

A third way, only suitable for frames of an unusual or decorative type, is to obtain or make ornamental corners in metal, which may be screwed or nailed on the front of the frame or at the edge. Repoussé-work corners in copper or bronze, attached by round-headed nails, look well on some kinds of dark frames.

PICTURE HANGING

In hanging pictures on walls it should always be remembered that they are hung to be looked at, and should look their best. Too often it is a matter of driving a nail in the wall and hanging the picture on it, scant attention being paid to its suitability with the other pictures as regards subject, colouring, size, etc. A picture rail (either rod or moulding) with hooks is a great advantage, for appearance, safety, saving the walls, and ease in hanging and adjusting. (Instructions on fixing rails of the two kinds mentioned are given elsewhere in these volumes.) Very heavy pictures are best hung with chains made in brass for the purpose, or iron to be painted the colour of the wall. The backs of the pictures have hooks screwed on instead of the usual rings, and can easily be raised or lowered by hooking into another link of the chains. This method of hanging also leaves a good space above for another picture or plaque (see Figs. 49 and 50). Light pictures may be hung the same way by using picture wire instead of the chains, the ends being twisted into a neat loop as in Fig. 51.

Cord, wire and chain are used for suspending pictures, probably the best all-round material being gilt copper-wire, obtainable in various thicknesses. In buying it, ask the dealer to guarantee that the wire is of copper and not of brass, because the latter "rots" right through



Figs. 56 and 57.—Device for Ensuring that Pictures of Different Sizes Hang at the Same Level

in two or three years or less, with consequent risk of smashing the frame as well as anything placed beneath it. A reliable and easily-made wire hook is shown by Figs. 54 and 55.

When it is necessary to use nails for hanging, they should be driven at a slight angle, as shown in Fig. 52; and if the pictures are of much weight, the wall should be plugged with wood as illustrated. At A is shown a nail simply driven into the wall, which penetrates the plaster and stops at the brick; at B a hole is drilled through the plaster and brick, and a wood plug driven in to take a stronger nail securely. The plugging of walls is fully described elsewhere in this series of volumes.

For lath-and-plaster partition walls, the wall hooks fixed with three long fine pins are best (see Fig. 53); but for heavy pictures, the top pinhole should be enlarged and a screw inserted.

Fig. 58.—Picture Grouping: Five Pictures on Eight Chains Hung from Wire Hooks

Common mistakes are to hang pictures too high and to have them leaning forward to an extravagant degree.

The arrangement of the pictures on the walls of a room must always be a matter of individual judgment. The first thing to decide is which pictures shall be put on each wall. The rings of hooks in the back of the frame should be 2 in. or 3 in. from the top corner. The cords or chains should be cut to allow the lower edges of the frames to be about 4 ft. from the floor, and a few inches over should be allowed on large pictures, which may have to be lowered. The pictures may then be hung uniformly in a level line round the room. Care should be taken to see that they all

Fig. 59.—Picture Grouping: Six Pictures on Six Chains Hung from Wire Hooks

have the same incline forward, which should be very slight.

It is easy to arrange for a number of pictures of different sizes to hang at the same level at their tops or bottoms, providing that a picture rail is fitted or that the nails are all inserted at the same height. Get any long strip of wood, insert a nail centrally near one end, and place down upon it a picture that has had its wire or cord adjusted to the height required. Pull the frame until the cord is taut, and if the pictures are to hang at the same bottom level, put a strip of wood across the first strip in contact with the lower edge of the frame and nail it down; if the pictures are to hang at a uniform top level, nail down the cross strip in contact with the top of the frame. Then, for cording the rest of the pictures, lay them one at a time on the long strip, attach the cord to one of the screw-eyes, hold the frame tightly to the cross strip, at top or bottom as required, pass the cord over the nail, and, after pulling it taut, attach it to the other screw-eye (see Figs. 56 and 57). Such a device is easily modified for use in hanging pictures in symmetrical groups such as are shown in Figs. 58 and 59.

Clock Cleaning and Repairing

Tools and Materials.—The appliances and tools necessary for clock cleaning and repairing are: A suitable bench or board; a vice; several pairs of pliers; cutting nippers; a pair of sliding tongs; a stout pin-vice; and a strong hand vice. Of screwdrivers several are required—a watch screwdriver for one, and another with a blade $\frac{1}{4}$ in. wide and a good strong handle. A star key or an adjustable key is a necessity. A stake and several small punches, round and flat ended, and a pillar file and a potance file will be required. Also a set of broaches for opening out holes, similar to watch broaches, only larger, some clock drills and a drill-stock (those bought ready-made answer every purpose), and a good cane-bow made from a halfpenny cane: a nice thin one, about 18 in. long, and strung with crochet cotton. Some clock peg-wood and one or two fine emery sticks (emery-paper on wood) will almost complete the outfit. Those who possess a small lathe of $2\frac{1}{2}$ in. or 3 in. centre will find it very useful for drilling and turning arbors, pinions, etc., and also for cleaning up certain parts. Most of these tools are illustrated in a chapter dealing with watch cleaning and repairing, appearing later in this series of volumes.

Of the materials used for cleaning, polishing, etc., the following will be found useful: Petrol to dissolve the old oil and grease, and a bowl to put it in; rotten-stone for scouring, and a brush (a soft clock brush) to use with it; whiting and a soft brush for polishing, and fine emery for grinding. Equipped with these, a start can be made; and provided that no parts want replacing, nothing more will be needed.

MECHANISM OF A SIMPLE CLOCK

The amateur is accustomed to regard the mechanism of a clock as something that is either mysterious or remarkably complicated. As a matter of fact, the ordinary clock—such, for example, as the German or American wood-cased one, the movement of which is shown by Figs. 1 and 2—is quite a simple machine entirely lacking in mystery, and the reader should disabuse his mind of the idea that it is at all mysterious. Figs. 4 and 5 are diagrammatic plan and elevation of the actual movement that is shown photographically by Figs. 1 and 2. The motion is derived from the mainspring which turns the main-wheel axle or arbor to which it is fixed. The main wheel drives a pinion on the shaft of the second wheel, which wheel, in turn, drives (1) the pinion on the axle of the third wheel, and (2) the wheel on the arbor of the minute hand. Taking (1) first, the third wheel drives the escape wheel by means of the pinion on the arbor of that arbor, but the speed of the escape wheel is regulated by the escapement, which consists of a pair of pallets which allow only one tooth to pass at a time. To the

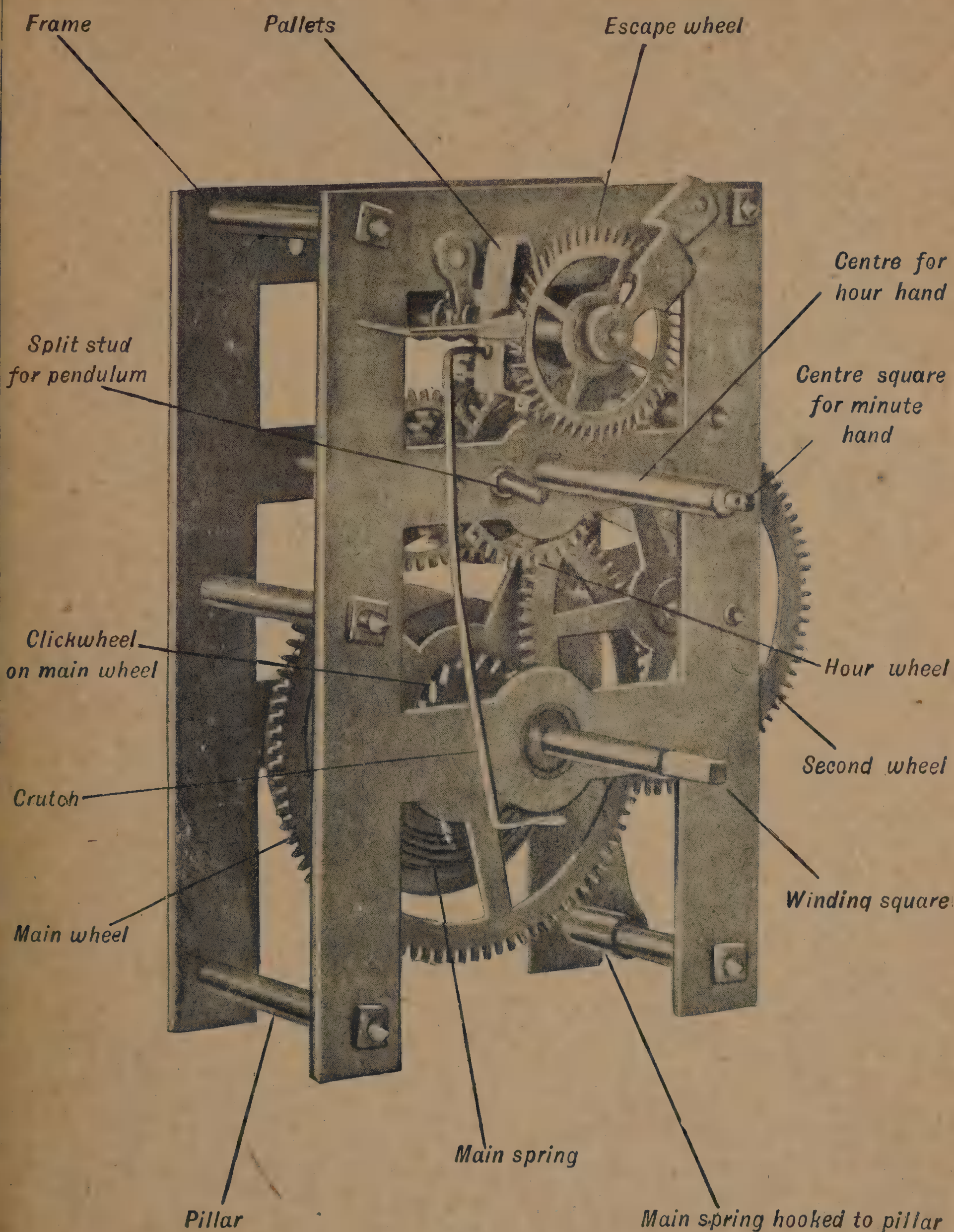


Fig. 1.—Photograph of Cheap American Clock Movement (Motion-work Side), with Parts Named

pallets is attached a bent wire known as a crutch, which communicates the necessary impulses to the pendulum, the length of which is carefully determined. Whilst, therefore, the mainspring provides the necessary energy to cause the wheels to revolve, the speed at which they do so is controlled by the escapement and pendulum. It will be remembered that the second wheel imparts motion to the minute hand direct by means of the toothed wheel fixed on the minute-hand axle; and this is the only connection between the running mechanism and the clock hands. There must be means of moving the hour hand at one-twelfth the speed of the minute hand, and this means consists of a simple reducing gear known as "motion work." The plan (Fig. 4) shows an axle to the left of the minute-hand arbor and parallel with it. This axle carries a wheel and pinion as shown, these meshing respectively with a pinion on the minute-hand arbor and with a wheel mounted on a sleeve, tube, or "pipe" which surrounds the minute-hand arbor and carries the hour hand. Thus, the first arbor drives the second one at a slower speed than itself; and the second one drives the hour-hand pipe at a still slower speed. Study of the diagrams (Figs. 4 and 5) will show clearly how this is accomplished. The above description includes all the essentials of a common spring-actuated clock.

The Escapement.—The most important part of a clock is the escapement, while at the same time it is the most difficult to understand and put into correct going order. A little inaccuracy in the escapement is quite sufficient to spoil the going of a clock, or even to stop it altogether. There are many amateur clockmakers capable of cleaning clocks and putting them together correctly; but most of them fail to detect escapement faults, and their work is rendered of no avail because they do not know how properly to adjust or repair this portion of the clock.

All pendulum escapements consist of an escape wheel and a pair of pallets. The object is to regulate the running of the clock train, only allowing one tooth of the escape wheel to pass at a time, and that at definite and regular intervals. The pendulum is the time measurer, and at each swing, or "vibration," as it is termed, moves the pallets, allowing a tooth of the escape wheel to pass at each double swing. At the same time, the power of the clock derived either from a spring or a weight is transmitted to the pallets, and through them to the pendulum by means of the "crutch," giving it a little push or impulse at each swing, just sufficient to keep it going.

It will therefore be seen that the escapement has a double duty to perform. It has to transmit the power to the pendulum, and to regulate the running of the clock at the same time. In transmitting the power to the pendulum there must be as little wasted as possible, or sufficient may not reach the pendulum to keep it moving through a large enough arc to allow the escape-wheel teeth to pass. This is the cause of stoppage in most faulty clocks.

Power is wasted sometimes by worn and rough pivots to the escape wheel and pallets. Therefore, in all clocks see to the escapement pivots, and, if rough, polish them. Side-play of the pivots in their holes will also waste the power, so if there is such side-play bush the holes and make them a good fit. Roughness of the pallet faces is a cause of wasted power. Often they are worn into ruts and holes, and when this is the case they should be smoothed out and polished.

The Crutch.—Pendulum clocks nearly all have a "crutch" attached to the pallets for the purpose of driving the pendulum. Sometimes the crutch is a loop or fork, in which the pendulum-rod hangs. At other times the crutch has a pin that enters a slot in the pendulum-rod. In both kinds the principle is the same. The crutch should not bind the pendulum-rod, but be quite easy and free; also it should have hardly any perceptible side-play. It if has side-play or "shake" it will waste much of the impulse that should be transmitted to the pendulum.

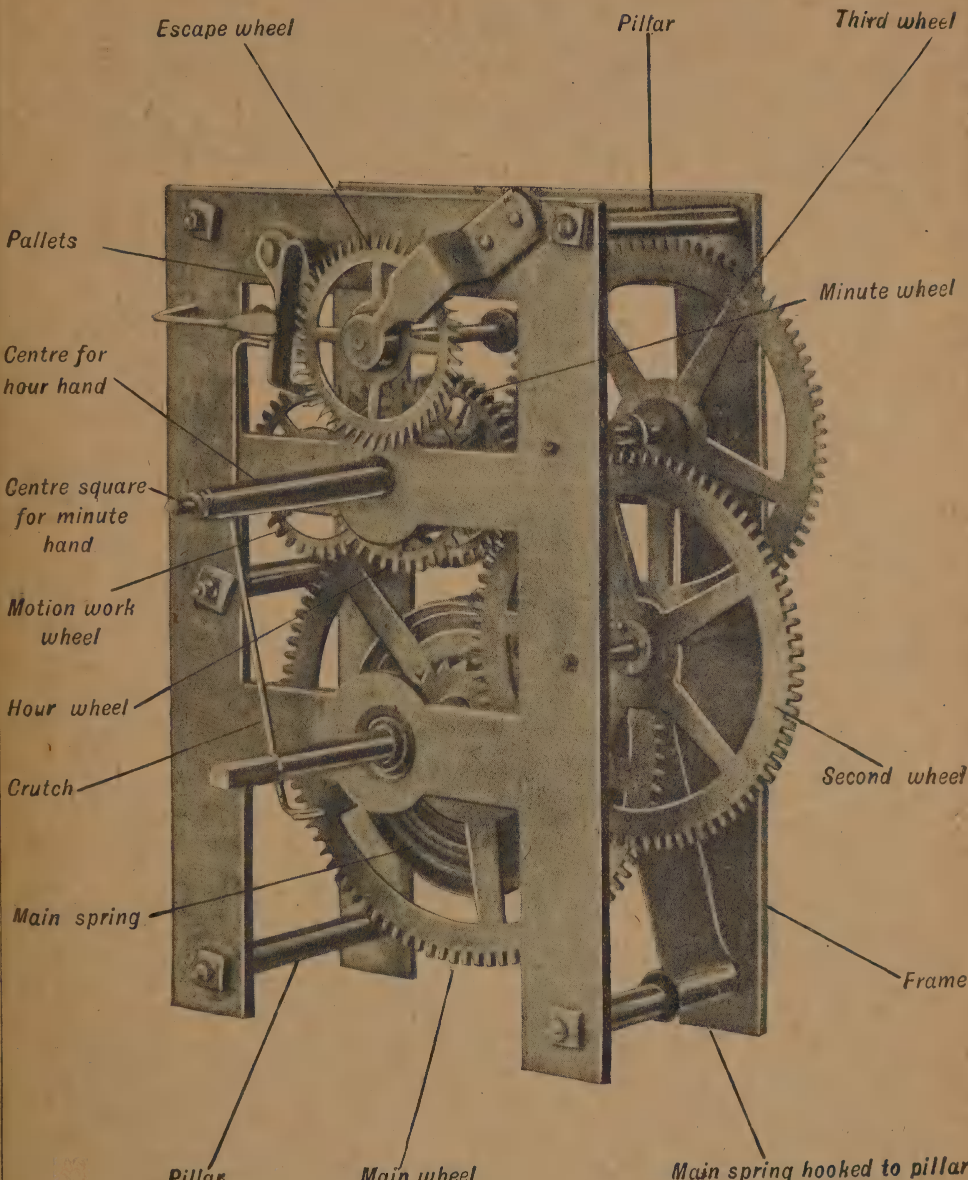


Fig. 2.—Photograph of Cheap American Clock Movement (Third-wheel Side), with Parts Named

If it is in the least tight, it will cause such a resistance as to stop the clock. The pendulum-rod itself where the crutch touches it should be smooth and polished, and the crutch polished to diminish friction. Although the centre of suspension and motion of the pendulum is supposed to be in line with the centre of motion of the pallets, and the two should work together as one, yet in practice this is an impossibility, and there is always a little sliding friction at the point of contact of the pendulum and crutch, just sufficient for any roughness or tightness to cause stoppage. A little oil should always be placed here; not a big drop, but just a trace.

Another point is that the pendulum-rod should not rest against the bottom of the slot in the crutch, but should be about

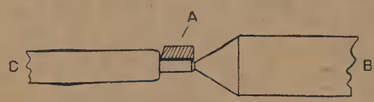


Fig. 3.—Polishing a Pivot

its centre, so that it is free to move a little backwards or forwards.

Repairing Pivots.—A worn pivot should be levelled down by turning in a pair of turns or a clock or watch lathe. Or it may be rested on a brass or steel runner with a hollow in it, and filed down while revolving. When levelled down it must be smoothed by a watch-pivot file, and finally by a flat burnisher, all the while rapidly revolving. This gives an ordinary or common finish. A better finish may be given by smoothing with oilstone dust and oil mixed into a paste and spread on a flat steel polisher made of soft mild steel. This has its surface filed flat to impart a slight grain and give a hold to the polishing material. The polisher may be 8 in. long, $\frac{3}{16}$ in. wide, and $\frac{1}{16}$ in. thick, and is used as a file or emery stick would be, being held flat on the pivot as the latter revolves in the lathe and moved to and fro. When the oilstone dust ceases to cut, wipe it off, re-file the surface of the polisher, and apply fresh.

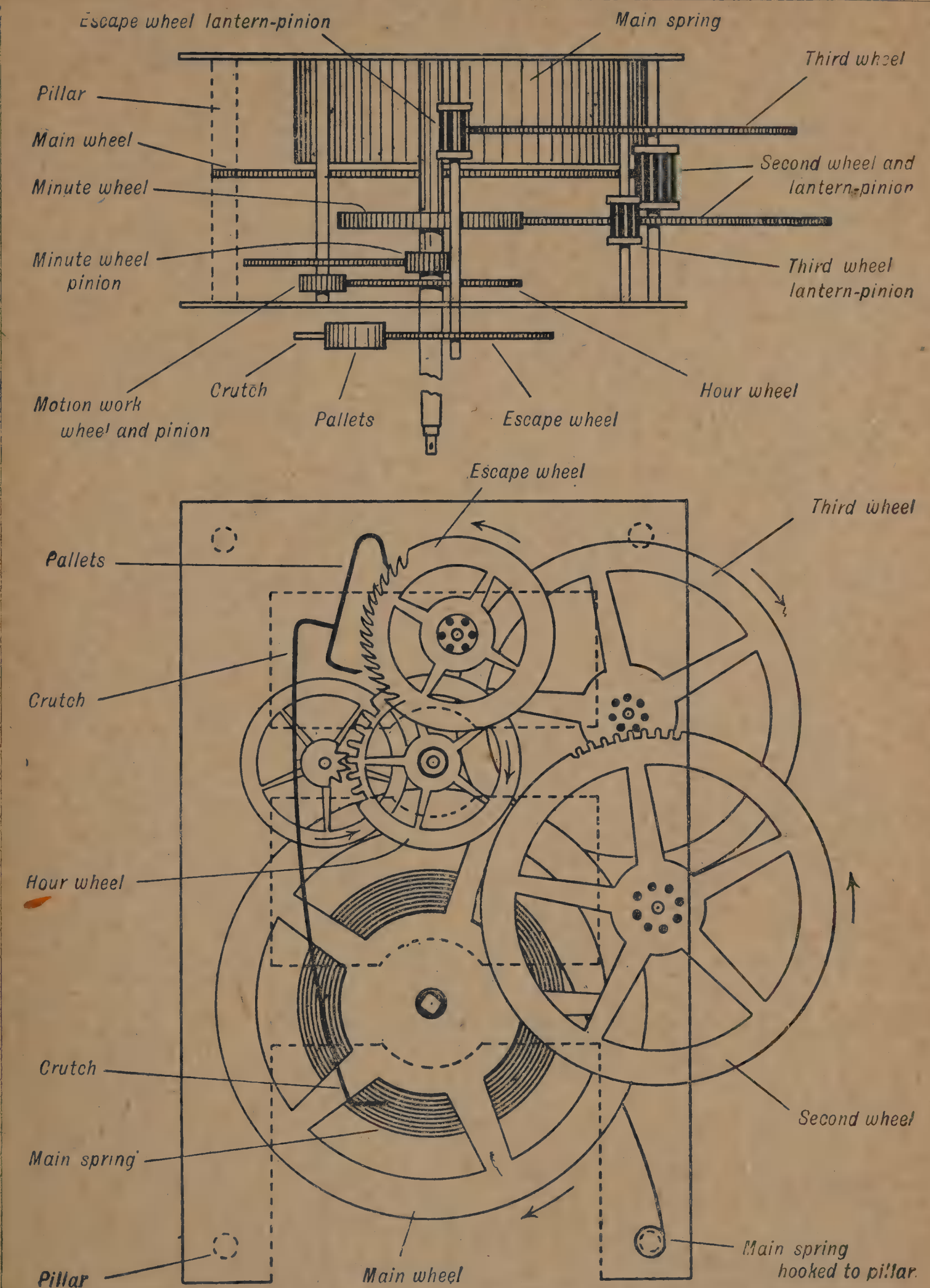
When smoothed until no cuts or turning marks remain, clean off and re-file the polisher, thoroughly clean the pivot, and charge the polisher afresh with a paste made of red-stuff and oil. Red-stuff is a polishing medium bought at clock-material shops, and looks like dark rouge. Use this in the same manner as before, until a brilliant polish is obtained on the pivot.

This polishing process would be quite out of place in a cheap American or German clock, but is worth doing in a good English one or a French movement. A section of the polisher as it lies on a pivot in the lathe is shown in Fig. 3, where A represents the polisher, B the back centre, and C the wheel arbor. A bevel will be noticed on the edge that touches the pivot shoulder.

A very rough-and-ready way, better than none at all, is to file and burnish worn pivots down by hand, holding the arbor in a pin-vice, and resting the pivot on a boxwood block in the bench vice. When very carefully done this is passable, and is often the readiest way to do up a pallet staff pivot that has a long crutch fixed to it, and cannot easily be revolved in a lathe. But to make a really good job of such a pivot the crutch must be got off somehow, if possible, and put on again when the job is done.

Bushing Pivot Holes.—A worn pivot hole is bushed by broaching it out with a broach (sold at clock-material shops), and inserting a brass "bush" (also sold for the purpose). For small clocks, bushes can be bought that are already cut off in short lengths; for larger clocks, like grandfather and English dial clocks, brass bushing wire is used. Bushing wire is brass rod drawn with a hole through its centre, like a brass tube with a very small bore.

Suppose a clock has a wide worn escape pivot hole. A bush or a piece of bushing wire is selected, the central hole of which will not quite go on the pivot. This is very slightly and evenly tapered down with a file on the outside at one end. The pivot hole is opened out by broaching until the bush goes in



Figs. 4 and 5.—Diagram Plan and Elevation of Cheap American Clock Movement

tight, not quite through the plate, oil being used with the broach. The wire is then cut off and filed flat on each end, so that, according to the judgment of the workman, it will hammer in the plate flat and not project much. The bush is then inserted from the inside of the frame plate, hammered in until the inside surface is flush and level, and then riveted a little with a punch on the outside where the oil sink is. The inside surface can then be smoothed by a fine, flat file, followed by grinding with Ayr stone or slate and water until level, and, if desired, polished with any good metal polish on a rag. A paste metal polish, it may here be observed, does well for polishing clock plates; but should be well washed off afterwards with benzoline or petrol. Keep these inflammable liquids away from naked lights.

Fig. 6.—Repairing a Crutch

The outside surface of the bush may be chamfered out to the level of the oil sink with a circular-faced cutting tool or drill, to form a nice finish. Finally, the new bush is opened out by broaching until it fits on the pivot, and when the wheel is put in the frame it spins quite freely and has a sufficient amount of endshake. In opening out a bush by broaching to fit a pivot, the broach should be kept quite upright, or else the hole will be made too large before the wheel will spin freely.

Some clockmakers, for a rough job, punch up worn pivot holes to close them. This is a bad practice, as it knocks the plates about, and, after all, only closes the edges of the pivot hole, which very soon wear down again.

Smoothing Pallet Faces.—Steel pallets are, or should be, quite hard, and, therefore, cannot be filed. When worn they can be smoothed down level with emery sticks (paper on wood), or by a soft-iron polisher like the pivot polisher already described, but larger and wider, used with a paste of emery and water. To polish them, for ordinary clocks use a finer emery stick, and a finer still, until an 0–3 is used to finish, the strokes being made lengthwise on the pallet faces and not across them. This emery stick will leave almost a polish. For a very particular clock, follow this with a flat pivot polisher and red-stuff and oil, as described for polishing pivots on p. 22, the pallets for this purpose being screwed in the bench vice.

Repairing a Crutch.—The inside of the fork of a crutch or a slot in a pendulum-rod should be burnished smooth with an oval burnisher set in a wooden handle, using a little oil to lubricate it. A crutch that is tight may be eased by a watch-pivot file before burnishing; but care must be taken not to file much off and make it too easy. A crutch that is too wide and rattles should be filed wider on one side, and a slip of brass inserted and soft-soldered in, washing the acid off well with water after soldering. The crutch can then be opened out and burnished to fit the pendulum. Fig. 6 shows what is meant, A being the slip of brass soldered in. If the crutch is a pin and the pendulum-rod has a slot, the same method may be pursued and a slip inserted in the pendulum slot. Do not attempt to hammer up or squeeze up a rod or a crutch, as the slot is never smooth or parallel afterwards.

Pendulum Suspension Springs.—A faulty suspension spring will often stop a clock. The spring should be straight and have no buckle or kink in it, or the pendulum will not swing straight. It should also be easy where pinned to the top of the pendulum-rod, so that when the pendulum hangs the spring goes exactly in line. Too stiff and short a spring makes the clock require more power to drive it, while a spring too long and thin allows the pendulum to wobble or roll as it swings.

There is no remedy for a buckled or kinked suspension spring; a new one must be fitted. For English eight-day dials, grandfather clocks, or bracket clocks, thin watch spring does very well. Cut off

a piece to the correct length, soften it for ¼ in. at each end by heating nearly to redness in a flame, and punch a round hole at each end, broaching them out to take the pins. Suspension springs for French, German, Austrian, and American clocks can be bought so cheaply that they do not pay to make.

Pendulum-rods should be straight. If curved the pendulum has a tendency to swing in a curve or roll. The bob should be a good fit, and the rating nut and screw fairly tight. A clock with a loose bob and rating screw is a nuisance, and difficulty will be found in regulating it.

CLEANING A CHEAP AMERICAN CLOCK

The simplest clock for the beginner to tackle is one in which the motive power, a weight or spring, is applied to a short train of wheels and pinions, and controlled by a pendulum, no striking or alarm work of any kind being added. This class of movement will now be considered, leaving Dutch, French, English, Vienna regulator, and striking and alarm clocks to form the subjects of later chapters. The ordinary American or German wood-cased timepiece being a common variety, a start will be made with this kind of clock. In order to get at the works, the first thing to do is to take off the hands. Begin by drawing out the pin from the centre square with the pliers, and remove the washer beneath it, putting both in a safe place. The minute hand can then be lifted off. Next take hold of the hour-hand socket firmly with the fingers and pull it off. It is pushed on to the centre friction-tight only, and a firm pull will bring it off.

This done, remove the dial, which will be found to be tacked or screwed on at the corners. Unhook the pendulum-bob for safety, and proceed to unscrew the clock movement from the back of the case. When this is out it will be found to be much like Figs. 4 and 5. These clocks are by no means all made alike; every make differs slightly in details and arrangement of wheels, but the same parts can be traced in any make from the description of one, as their use is the same in all cases. The outer end of the mainspring is hooked on to one of the pillars of the frame, and the inner end to the arbor or axle of the main wheel. The second wheel drives the minute hand arbor, and the hour hand is worked by the "motion work." There is an intermediate wheel leading to the escapement, or 'scape wheel, and "pallets." Attached to the pallets is a long wire, the crutch, terminating in a loop, through which hangs the pendulum-rod.

Taking Clock to Pieces.—In proceeding to take the clock to pieces, the first thing to do is to remove the pendulum-rod. With the small blade of a pocket-knife prise open the split brass stud, and lift out the pendulum-rod, drawing

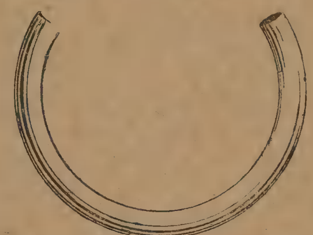


Fig. 7.—Mainspring Clamp

it through the crutch. On no account undo the pins holding the frame together until the power of the mainspring is either held in or allowed to spend itself, or disaster will result. One way of taking the clock to pieces would be to take off the pallets, let the wheels run until the power of the spring is spent, and then take the frame apart. This method is all very well as far as mere taking apart is concerned, but will in all probability give a great deal of trouble when the time comes to put all together again, on account of the spread condition of the mainspring and the difficulty of confining it sufficiently to allow the wheels to be placed in position; therefore, the way to proceed is first of all to wind the spring *right up*, and then clamp it by means of a mainspring clamp (Fig. 7), which is sent out with a new mainspring, and serves to confine it. To apply the clamp, slip it over the wound-

up spring, hold it in position while removing the pallets, and then let the clock run. The spring will expand and tighten in the clamp. The clock can then be taken apart safely, leaving the clamp on until the clock is again put together.

With one of these mainspring clamps in use, the worker can wind the spring up full, and pass a piece of string round it, pillar and all, and tie it up, letting the wheels run as before until the spring will unwind no further. This method is not so good as the first because the spring and main wheel cannot be removed from the back plate for cleaning.

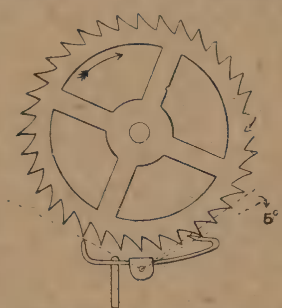


Fig. 8.—American Recoil Escapement

Examining the Movement.—Take up the main wheel and spring, and, placing a key upon the winding square, try the "click-work"—that is, see if the click is sound and the ratchet teeth all right. If the click is damaged, take it off, and rivet a new one on. Clicks can be bought very cheaply. Examine all the pivots, and if any are bent, straighten them carefully with a pair of pliers. Look to the wheel teeth, especially those of the escape-wheel, to see if there are any bent teeth. If there are, carefully straighten them. Take up the pallets, and see if the faces are cut by the escape-wheel teeth. If they are, treat them as already described. See if the wire crutch is firmly riveted into the pallets, and not loose; also that the pallets are firmly riveted to the brass piece which works on the pivot. Try them on their pivot, to see if the holes are worn very wide and oval. If they are, take a small broach and open them out a trifle—just enough to make the holes round; then knock out the pin which serves as a pivot on the plate, open out the hole a little, and knock in a large-sized steel needle quite tightly, the needle to be sufficiently large for the pallets to work upon it without shake. Then cut the needle off to the correct length.

Cleaning.—Next immerse all the parts in the benzoline (or petrol) and with a brush wash them thoroughly free from all grease and sticky oil. They may then be dried with a duster, laid by for a few minutes, each wheel well brushed, and the pinions cleared out with a clock-peg cut to a point. The plates are wiped dry, and all the pivot holes "pegged" out clean. Take the minute wheel and try the "set-hand work." It will be seen on examination that the minute wheel is only friction-tight upon its pinion, and on the application of a little force can be turned round upon it. Now the tendency in these cheap clocks is for this to wear loose, and cause the hands to move too easily, thus lagging behind while the clock goes, causing it apparently to lose time. If, therefore, this movement is too easy, give the washer a knock down to tighten it.

The Escapement.—The escapement illustrated in Fig. 5 is a variety of the American recoil, a type that is found in nearly all small American pendulum clocks and many of the larger ones. A more usual variety is that shown in Fig. 8. The pallets should not be allowed to rock on their pin pivot. Either fit a larger pin, or bush the brass holes until a good fit is obtained. Also look particularly to the top escape-wheel pivot, and see that it has no side-play. These are weak points in this escapement. Should these pallets be very unusual in their drop, it is an easy matter to soften them, bend until correct, and re-harden them. New pallets can be bought for a few pence, therefore it is only wasted time doing much in the way of repairing old ones; but in case readers would like to try, the same instructions apply as

are given elsewhere in these volumes in connection with other recoil escapements.

Some American dial clocks have dead-beat escapements like Fig. 9. In these clocks, if the pallets begin to rock on their pin, a larger pin must be fitted. As in all dead-beat escapements, see that the teeth just lock and no more. Adjustment is sometimes provided for by a movable stud, on which the pallets are mounted. At other times, the bar of the brass frame, or the cock holding the escape wheel in position, must be bent a trifle to correct the locking. Or, failing this, the pivot holes may be drawn and bushed. Pallets of the above escapements are of correct shape when lines drawn, as shown, from the pin through the faces form the angles indicated in Figs. 8 and 9.

Putting together American Clock.—The clock can now be put together again. First, take the bottom plate, and on it place in position the main wheel with the mainspring upon it, clamped, and the other wheels. Then put on the top plate and escape wheel, pinning them on securely. When all the wheels run freely, put on the pallets, observing that the crutch is quite free of the top plate at its lower end and does not drag on it. The mainspring can then be wound up and the clamp taken off. If all is free the clock will at once start off ticking at a rapid rate. By placing a finger on the crutch, and allowing the wheel teeth to pass slowly one at a time, it will be seen that a tooth gives one pallet an impulse, and then the wheel runs till another tooth falls on to the other pallet.

Now, to be correct, this distance, the "drop" of the tooth, should be very small compared to the impulse. If it is excessive, power will be wasted, and very little will reach the pendulum. If the wheel has much "drop," the depth is said to be too shallow, and to remedy it the pallets must be made to approach a little nearer to the wheel. To do this, first stick a peg between the wheels to prevent their running; then remove the pallets, and with a pair of pliers turn round by the slightest possible amount the arm that carries the pallet pivot. Then replace the pallet, and try again. If too deep, the teeth will not pass. It is a good rule to deepen these escapements as much as possible without making the escape wheel teeth catch. Now put a little clock oil on to each pivot and a little on the pallet faces; also oil the coils of the mainspring and the pallet pivots. Then replace the pendulum-rod, nipping the brass stud tight with a pair of cutting nippers, near its base.

The movement can now be screwed into its case once more. Before putting

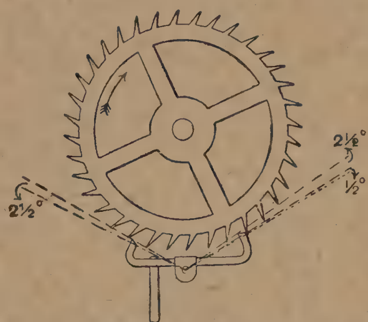


Fig. 9.—American Dead-beat Escapement

on the dial and hands, put on the pendulum-bob, and stand the clock on a level shelf, or on the board, if that is quite level, and see that it is "in beat." To test this, let the pendulum swing but little—only just enough to keep the clock going. Listen to see if it ticks evenly, thus—tic-tic-tic-tic—or whether it goes tic-tic, tic-tic—in twos. If the latter, it is not in beat, and the crutch must be bent with pliers until it beats quite evenly.

When in beat, the dial and hands may be put on. See that the hour hand is pushed on properly, or the minute hand when pinned on will bind it and stop the clock; and before putting on the dial, see if the pendulum-rod hangs freely in the crutch, and does not stick in it, and place a very little oil at the point of contact.

CLEANING AND REPAIRING ENGLISH CLOCKS

The English clocks to be dealt with in this chapter include the grandfather, the "eight-day dial" and the skeleton clock, and notes will also be given on the adjustment of a number of different escapements.

Grandfather Clock.—A grandfather striking clock movement with dial removed is shown by Fig. 11, this illustrating the usual arrangement of the striking mechanism (see also the photographic views, Figs. 10 and 13). Fig. 12 is a key to the train of wheels between the plates, which wheels cannot be shown in Fig. 11. When cleaning the clock, before taking anything apart, place the movement with the dial removed, as in Fig. 11, in its case with the hands on and turn them round, causing the clock to strike. Notice exactly what happens, and from it learn how to put the parts together again.

On turning the minute hand, as the hour is approached a pin in the minute wheel B lifts the tail end of the warning lever H, which in turn lifts the rack hook G. The rack E is thus liberated and falls until its lower end rests against one of the steps of the snail D. The depth of these steps regulates the number of blows struck at each hour. Before the rack fell, the running of the striking train of wheels was prevented by the gathering pallet F resting upon a stop pin in the rack. But when the rack falls the gathering pallet is released and the train runs until a pin in the warning wheel M (Fig. 12) catches against a stop block attached to the warning lever. This run is called the warning, and takes place a few minutes before the hour. The minute hand continuing to advance, the pin in the minute wheel passes the end of the warning lever, and at the hour the lever falls again and liberates the warning wheel. The striking train then runs, and at each revolution of the pallet wheel L the gathering pallet gathers up one tooth of the rack and a pin in the pin wheel K causes one blow to be struck. Continuing to run and strike, the rack is at last all gathered up and the gathering pallet once more comes to rest against the stop pin in the rack. This action should be studied closely until the functions of each part are thoroughly understood. Then take the movement to pieces. First take out the pallets S and crutch. Then remove the rack, hour wheel C (Fig. 11), warning lever, rack hook, gathering pallet, minute wheel, and cannon pinion A, in the order named. Take off the bell and bell standard, and take the plates apart. Be careful to keep the striking train of wheels separate from the going train. With a stiff brush like a tooth brush bearing powdered rottenstone and oil mixed to a paste, scrub the plates up and down in straight lines until they are bright. Similarly scrub the wheels and all other brass parts. Then pour some petrol or benzoline into a basin (keep a flame away from this), and with the same brush thoroughly wash the rottenstone and oil from all parts, and dry with a clean duster. With wooden pointed pegs clean out the spaces between the pinion leaves, and peg out the pivot holes in the plates until they are quite clean inside. Brush out the wheel teeth.

The movement can then be put together again, a little oil being given to the clicks and click springs on the barrels. When the bell hammer and all the wheels are between the plates and in place, try each to see whether the pivots have much side play in the pivot holes. The most important wheel is the escape wheel R (Fig. 12). If its pivot holes are very wide, they must be bushed—that is, opened out, filled with bushing wire, and re-drilled (see p. 22). The wire has a central hole in it, and this gets over the difficulty of re-drilling. A bushed hole is smoothed off level inside and opened out by reamering to fit the pivot quite easily but without side play. The pallet holes, if wide, must also be bushed. Then put on the minute wheel, rack, rack hook, warning lever, and gathering pallet temporarily, to see that the striking train wheels are in correctly. To test them proceed as follows: Wind up the striking barrel J about a turn and give the gut a twist round the fingers. Then, pulling on the gut, cause the rack to fall a few teeth and let the pallet gather it up

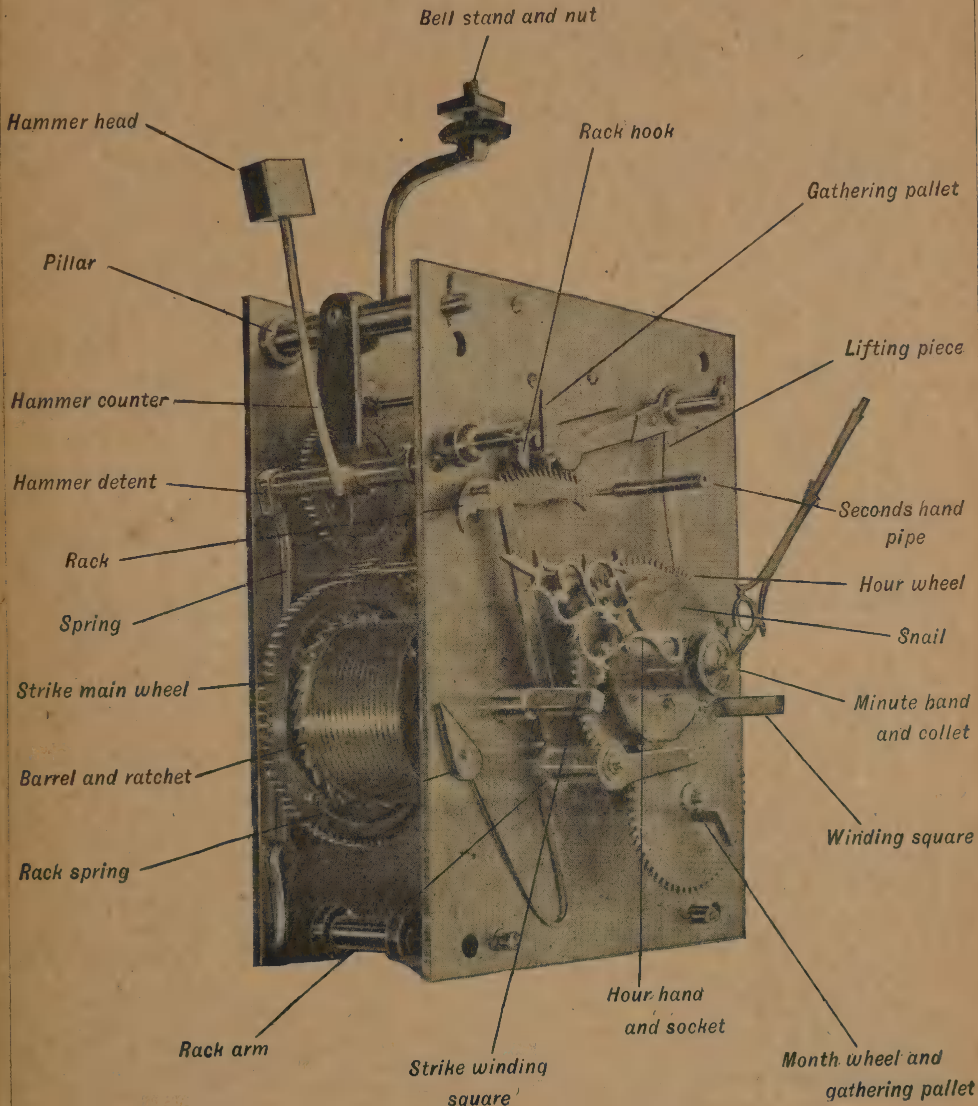


Fig. 10.—Grandfather Clock Movement (Striking-movement Side)

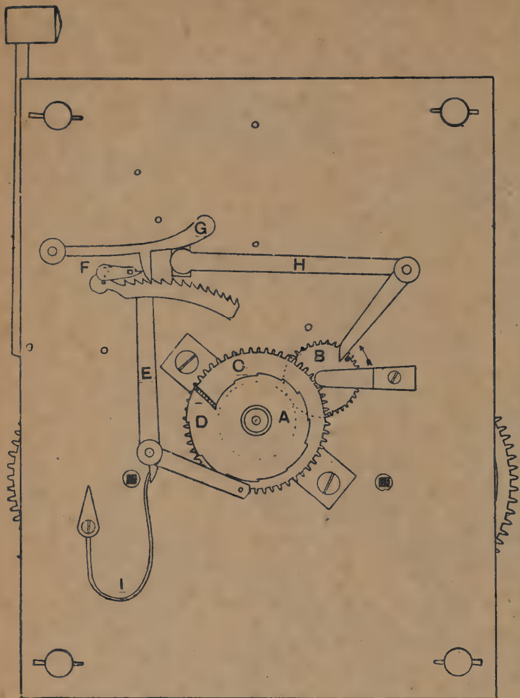


Fig. 11.—Striking Movement of Grandfather Clock

warning-wheel pinion. These are the two points that must be attended to in any striking clock.

Next oil the front pivot holes with good clock oil, and put on the cannon pinion. Put the minute hand on it and turn it round to see when it strikes. See that when the warning lever falls the minute hand points exactly to the hour; the teeth of the cannon pinion can be shifted in the minute wheel to adjust this. Do not forget the flat brass spring under the cannon pinion. Then pin on the rack, rack hook, warning lever, etc., and put the hour wheel and snail on in such a position that the rack tail falls in the centre of a step at the hour. This can be regulated by shifting the teeth in the minute pinion. Oil the lifting pins in the pin wheel, the hammer spring where it touches the hammer, the rack spring I (Fig. 11) where it touches the rack, the stop pin in the rack, the warning pin in the warning wheel, and the lifting pin in the minute wheel. Also oil the back pivots. Then clean the pallets with the petrol or benzoline, and the

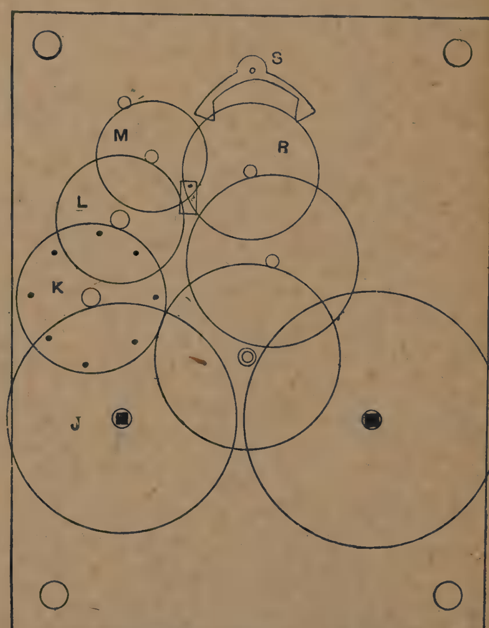


Fig. 12.—Train of Wheels of Grandfather Clock

slowly. Observe how the train stops when the gathering pallet stops against the rack pin. It should do this immediately after the last blow is struck, so that when the train is at rest the hammer tail is quite free of the lifting pins in the pin wheel. If it stops with a pin against the hammer tail, it is wrong. Shift the gathering pallet to another square, and try it on all four sides until one is found that is right. If none seems right, but a midway position seems to be required, the top plate of the frame must be gently lifted up and the pin wheel turned one tooth in the pallet wheel pinion. Then try again, and finally pin on the gathering pallet. Next see whether the warning is correct. When the striking train stops, the pin in the warning wheel should not be close to the stop block on the warning lever, but should have a run of at least a quarter of a turn before coming to it. If too close, the plate must be raised and the teeth of the pallet wheel shifted in the

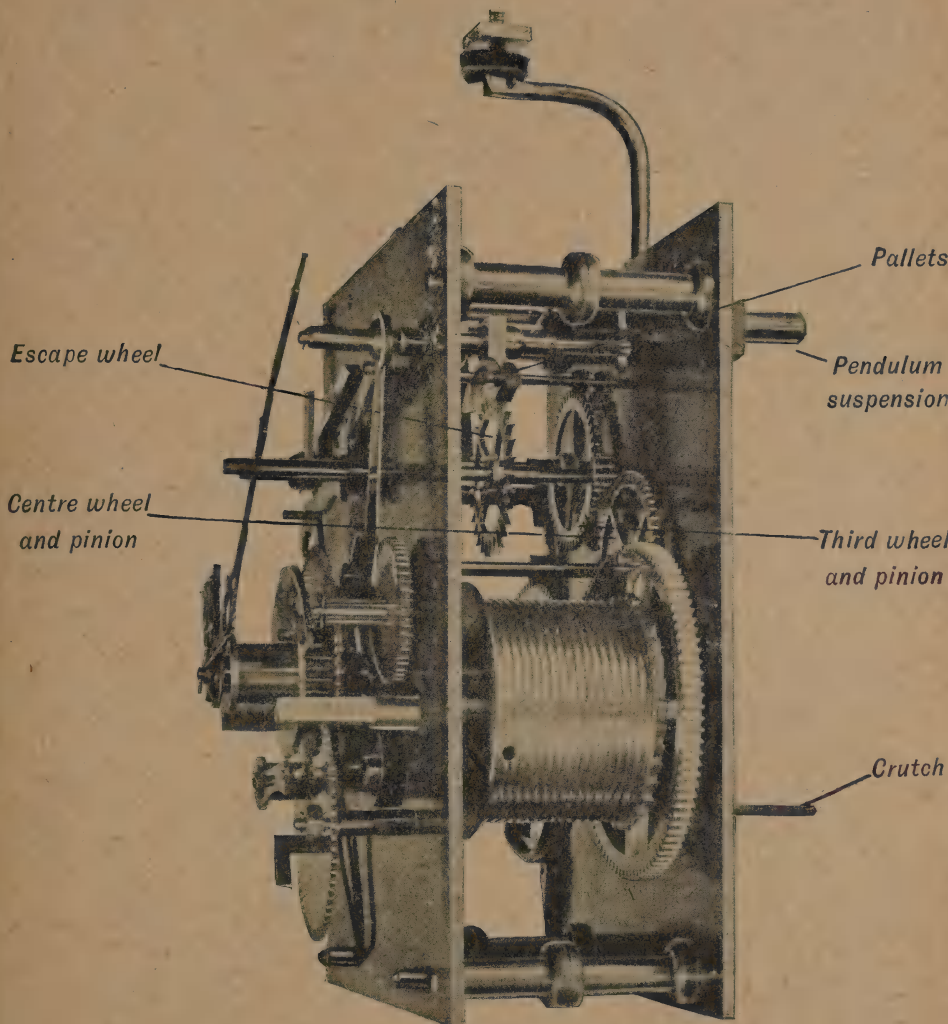


Fig. 13.—Grandfather Clock Movement (Side View)

crutch in which the pendulum-rod goes. If the pallets are in fair condition, put them in place and oil them and their pivots, also the slot in the crutch. If they are very badly worn, it will be best to buff out the ruts with an emery-stick (emery-paper on wood), and get a small piece of watch mainspring as wide as the pallet faces. Solder a piece on each pallet face with tinman's solder, washing well in water to remove all acid. Then try the pallets in the clock, and if necessary trim off the points with a file until the wheel trips through satisfactorily without catching.

The dial can next be put on and the clock started. If after going a little while the pallets catch upon the points of the escape-wheel teeth, reduce the offending point a little by filing the pallet. See that the pendulum-rod is not sticky where it passes through the crutch, and give it a little oil there. Let the clock be exactly in beat. To test this, bring the pendulum to rest and mark the back of the case with a pencil behind the bottom of the rod. Draw the pendulum to one side until it ticks, mark the point, then draw it to the other side and mark that point. If the clock is in beat, these two marks will be equidistant from the central point. If unequal, bend the wire crutch to one side and note the result. Work in this way until correct.

It is important to see that the hands are quite free from each other, the dial, and the glass. See that the lines wind up straight upon the barrels to the top, and that they are not long enough to allow the weights when run down to touch the floor, or the lines may twist up.

"Eight-day Dial" Clock.—English clocks are of various patterns, but one style of workmanship will be found in all. The ordinary eight-day English shop or kitchen clock, commonly known as an "eight-day dial," is well and solidly made, is a good timekeeper, and will last a lifetime. Its mechanism is extremely simple, and there is nothing to get out of order. The weakest point is the gut line, which chafes through after a few years' wear. In the best the gut is replaced by a steel chain, which effectually gets over the difficulty.

Taking Apart.—To take the clock apart, first remove the pendulum, unpin the minute hand, and remove it. The hour hand is held by a small screw, which should be withdrawn, and the hand taken off. Then lay the clock upon its face, remove the four wooden pegs at the sides, and lift the back of the case right off. The square movement itself will be found to be pinned to the dial and front part of the case. Remove the four pins from the dial feet, and it will come off altogether, leaving the dial alone screwed to the front of the case. This can be put on one side. Do not attempt to let the spring down, but put a little oil to the pivots, and, having removed the motion work and the pallets, let the clock run down. As it does so, notice if the wheels and pinions run smoothly, and if they are true. When quite run down, put a hand-vice or a large key on the square of the barrel arbor, and raise the click, letting the spring down gently. The plates can then be unpinned, and the clock taken apart. The parts may be cleaned with rottenstone, etc., as described for the grandfather clock.

Overhauling.—Before putting together, look to the pallets, and smooth out any marks of wear; examine the pinions, and if any are badly cut, the wheels had better be shifted along their arbors to work in another place. Sometimes these are soldered on, and shifting them gets them out of truth. In that case nothing can be done unless the wheel seat is turned afresh; a shoulder would be turned to receive the wheel tightly, and then be riveted over with a punch. Look for wide pivot holes, and if there are any bad ones, bush them as described on p. 22. The worker having satisfied himself on these points, put the barrel, fusee, and wheels in position between the plates, and pin together.

Winding-up, etc.—Now take the gut, and carefully wind it up on the barrel, turning the latter with a key. When all is wound on, put on the outside ratchet, and wind it, or "set it up," about half a

turn. Pin the ratchet on, and screw the click tight; then put in the pallets, and wind the clock up. In doing this, the gut must be carefully guided on to the fusee,

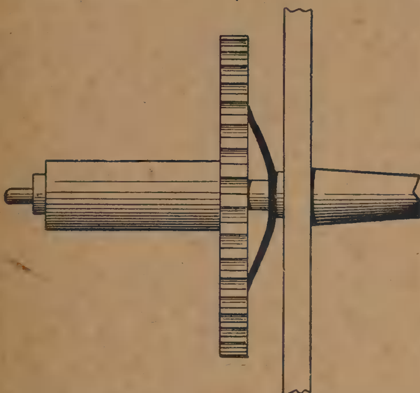


Fig. 14.—Minute Wheel of English Clock

and not on any account be allowed to run off or drag in a slanting direction. The best way to guide it is to hold a smooth file-handle, or something of a like nature, against it as you wind, bearing sideways upon it, to keep it straight.

In a chain clock, the chain is first hooked in the barrel and all wound upon it, then hooked in the fusee, and manipulated as the gut described above. Oil all pivots and the pallets, etc., and put on the motion work. There is a short brass spring that goes on under the minute wheel, as in Fig. 14. By no means put it on wrong side up, or the clock will certainly stop. The two points should bear on the under side of the minute wheel.

When all together, and ready to hang up, see that the crutch is free in the slot in the pendulum, and does not touch either at the top or bottom, nor stick in it. Just a trace of oil should be put upon the pin. To set these clocks in beat, the crutch must be bent.

Renewing Gut Line.—To put on a new gut line, take the movement to pieces, and take out the old one from the barrel. To get the fusee end out, the fusee must be taken to pieces. A circular piece of brass will be found outside the fusee wheel or main wheel; it is a kind of key, and requires to be unscrewed or unpinned and then taken off. While it is off it can be cleaned, and fresh oil

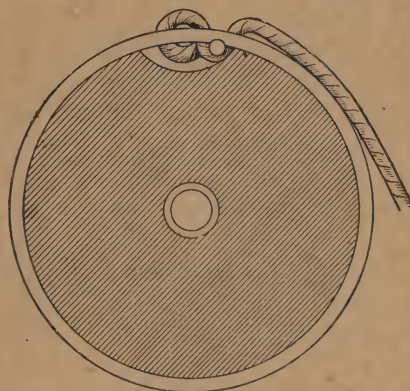
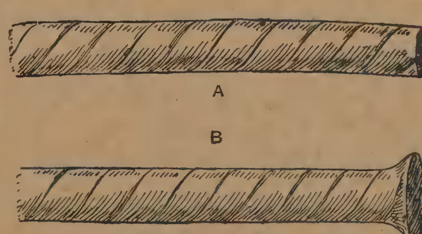


Fig. 16.—Fastening Gut at Barrel End

applied to the ratchet and click-work. Procure a new line A (Fig. 15) of the same thickness, and measure it to correct length, allowing for fastenings. Make a single knot for the fusee end; and to prevent it coming undone, get a small, flat piece of iron or brass, and heat nearly to redness in a gas flame. Apply this to the end of the gut, which will expand into a kind of mushroom head (see B, Fig. 15); the object of this "searing," as it is called, is to prevent the end pulling through. Fig. 16 shows the method



A

B

Fig. 15.—Gut Line, Plain and Seared

of fastening the barrel end, which must be seared in the same way.

The Skeleton Clock.—The mechanism of this kind of clock is similar to that of the eight-day dials just described. Usually there is the addition

of a bell at the top and a hammer, which is caused to strike one blow at each hour—not a very complicated affair. These clocks want most careful cleaning. Every part must be thoroughly well cleaned with rottenstone and polished with chalk. The cuttings in the plates must be done with strips of washleather and rottenstone, and afterwards with more leather and a peg. All steel-work also ought to be polished and burnished with a burnisher and oil. It is all visible, and therefore no pains should be spared in getting it up well. Fig. 17 shows the train wheel scheme ; Fig. 18 the back cock and pendulum suspension ; and Fig. 19 a side elevation of the clock movement. In Fig. 17 A represents barrel ; B, fusee ; C, centre wheel ; D, third wheel ; E, escape wheel ; F, cannon pinion ; G, minute wheel ; and H, hour wheel.

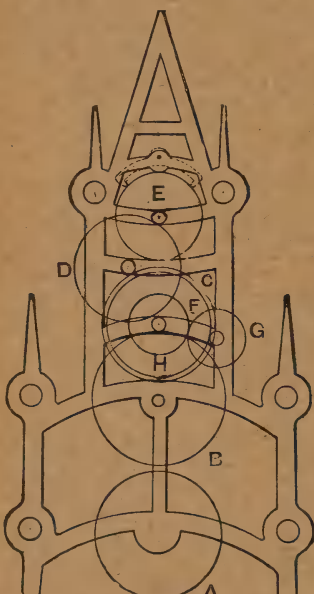


Fig. 17

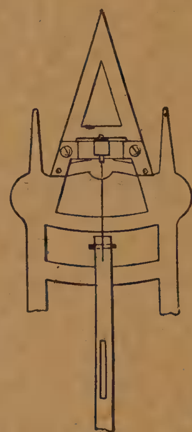


Fig. 18

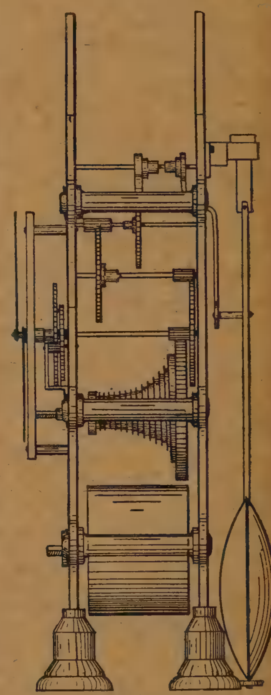


Fig. 19

Fig. 17.—Train of Wheels for Skeleton Clock

Fig. 18.—Back Cock and Pendulum Suspension

Fig. 19.—Side Elevation of Skeleton Clock Movement

Correcting English Recoil Escapements.—Fig. 20 shows an English recoil escapement as used in grandfather, eight-day dial, and English bracket clocks. The face of the entering pallet C lies horizontally, while that of the exit pallet D is about perpendicular. When so, the angles of impulse will be about correct, and when not so, as sometimes will be seen in clocks, the escapement is sure to be faulty. The "drop" of the teeth on the pallets A deserves special consideration. When a tooth passes along the face of pallet C and slides off its tip, another tooth "drops" on the face of the pallet D. And when this tooth escapes from pallet D, the next tooth in order "drops" on pallet C. The drop should be small, being just enough to ensure that as the pendulum swings, the pallet point will not catch on the back of the tooth that has just left it. A very small amount suffices for this. Then the drop on each pallet should be equal, and the drop should be equal all round the escape wheel on each tooth.

When the drop is unequal round the wheel, being slight in one place and more in another, it shows that the wheel is not true, or that it is not truly mounted on its pinion. When the wheel is not quite true it can be mounted in the lathe or

turns, and rapidly revolved while a very fine file, like a watch-pivot file, is gently held to the teeth points. This should be continued until every tooth point has just been touched. This process leaves a slight burr on the teeth, and should be removed by a watch-pivot file. If any teeth points are thick they may be filed thinner by a half-round file, operating on the curved parts only. Do not touch the straight sides. The wheel being topped true, if the drop is still unequal at different parts of it, it is caused by untrue mounting on its pinion, and cannot very well be altered.

As before stated, the drop should be equal on each pallet; very often it is unequal. Excessive drop on one or both pallets means power wasted. If excessive on both, the pallets may be brought nearer to the escape wheel by lowering the back cock. Bending its steady pins and filing the screw holes slightly oval will effect a little alteration. More may be done by opening out one pivot hole, filing it towards the escape wheel with a rat-tail file, and re-bushing.

When got as deep or close as it can be set, the drop may be unequal on each pallet. If it is more on pallet C, while there is hardly any at all on pallet D, a little taken off the point of pallet C will equalise matters by allowing teeth to drop off it earlier, and so give more drop on C. Then if too much on both, bring the pallets a little nearer to the escape wheel.

If the drop is too great on pallet D and just right or not enough on pallet C, take a little off the point of pallet D, as shown by the dotted line in Fig. 21, which is much enlarged. Emery-sticks will make these little alterations, and should be used on the backs of the pallets, not their impulse faces, as shown in Fig. 21. After this, see that there is no burr on the pallet corner. When made equal thus, the pallets may again need bringing a little nearer to the wheel.

If the teeth points catch, there is evidently not enough drop, and a little may be taken off the pallet back, or the pallets may be got a little farther from the wheel. Bringing the pallets nearer to the wheel will be found to decrease the drop on C and increase that on D, so that if there is insufficient on D and too much on C, simply bringing the pallets a little closer will often do.

Alternative Methods of Correcting Escapements.—When pallets have been badly worn, and the wear buffed out with emery, there is often not enough metal left in them to correct the escapement in the way just described. Then there are two courses open. The pallets may be softened by making red-hot,

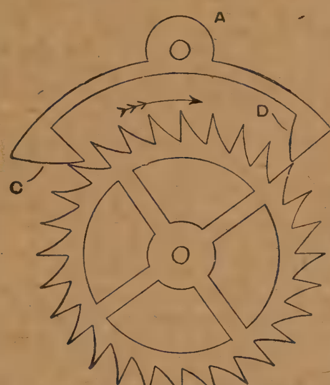


Fig. 20.—English Recoil Escapement


Fig. 21

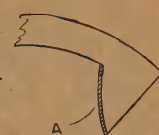


Fig. 22

Figs. 21 and 22. —Pallet and Recoil Escapement

brought much nearer to the wheel by drawing the pivot holes downwards, and then filed up to give correct impulse and drop, following the rules just explained. After this they must be hardened by heating to a bright red and plunging into water, and finally smoothed and polished by emery buffs.

An easier method is to face such pallets with pieces of watch spring. Obtain a piece of watch spring as wide as the pallet faces, file it bright on one side, and tin it with soft solder. Tin the pallet faces, and then, laying on the spring, heat gently until the spring goes down flat. If heated carefully the spring need not be softened, and will then remain at a blue temper that, though not so hard as hard steel, will yet wear for some years, and when worn may be readily

replaced. After soldering wash off the acid well with plenty of water, and polish up the faces, adjusting the "drops" as before. Fig. 22 shows a pallet "faced" as described. A represents the piece of watch spring.

Another way of getting over this difficulty when the pallet faces are wide enough is to move them along on their arbor until the escape-wheel teeth work on a fresh and unworn part, when, of course, they will be correct again. A difficulty may perhaps be found in moving the pallets, as very often the brass collet to which they are riveted is brazed on. If so, perhaps the escape wheel can be moved, which will come to the same thing; but this is more difficult and needs some

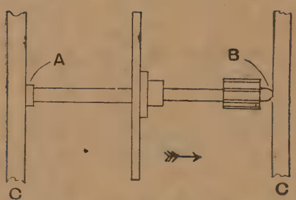


Fig. 23.—Escape Wheel and Pinion Moved to Correct Escapement

skill. Moving a wheel collet bodily along its arbor always throws the wheel a little out of truth, and in moving an escape wheel the wheel should be taken off its collet by turning the riveted part away, the brass collet turned back so that the wheel goes farther on, and the wheel remounted and riveted on as before. After re-mounting, the wheel always should be "topped" as before described, and this having a tendency to increase the drop in the escapement, moving the escape wheel is not so good a way of overcoming wear as moving the pallets would be.

A third way is to bodily move the escape wheel and pinion or the pallet arbor, by turning back one pivot shoulder and putting in a "raised bush" at the other end to make the endshake correct. When the escape pinion is badly worn as well as the pallets, moving the escape wheel and pinion thus will correct both faults. Fig. 23 shows an escape wheel and pinion moved thus. A represents the raised bush, B the pivot turned back, and C C the plates. The arrow shows the direction in which the wheel has been moved. If it is inconvenient to move the escape wheel in this way, the pallet arbor may be moved instead.

Making New Pallets.—Sometimes pallets are so badly worn, and have been doctored up so many times, that there is really nothing for it but to make and fit a new pair. A steel forging can be bought at the clock-material shop, and will save much heavy filing. Before beginning work on the forging, draw out the escapement exactly to scale on writing paper. Lay the paper on the clock plate, and mark the escape and pallet pivot holes, so as to get the distance of the centres. Then enlarge the escape pivot hole truly until the arbor goes through. Push it through, and press the escape-wheel teeth points on to the paper, to get an impression. Now, taking Fig. 20 as a guide, draw in the impulse face of pallet D, its point coming exactly to a tooth point. Let it be vertical and a trifle curved. Draw in the impulse face of pallet C, letting it be horizontal and also slightly curved. Its point should penetrate the escape wheel exactly midway between two teeth, and its face should just touch the tooth point before it as shown. The backs of the pallets should be straight lines pointing to the escape-wheel centre. The pallet body may be drawn in any shape.

Then cut out the paper to the exact shape of the pallets. Lay it on the forging, and mark and drill the central hole, after which the outline may be scratched on the steel with a graver point, and the forging filed up to shape and size. When approaching the right size fit the rough pallets on to the arbor rather a tight fit, and place in the clock frame together with the escape wheel, and file a little off as shown to be necessary, so that the teeth can be just forced past the pallets with no drop. In this condition they may be hardened by heating to a bright red and plunging in water.

After hardening place in the frame, and, trying as before, ease the depth and give just a little drop on each pallet by smoothing with buff sticks, finally polishing the impulse faces.

Correcting English Dead-beat Escapement.—The English dead-beat escapement shown by Fig. 24 is such as may sometimes be seen in a grandfather clock or an English bracket clock, and it is the one generally used in regulators. It is termed "dead-beat" because the escape-wheel teeth rest motionless on the faces of the pallets between each beat. Each pallet has two acting faces: A, the resting or "dead" face, and B, the impulse face.

In these escapements the tendency of wear is to cut a groove on the dead face and across the impulse face, rounding off the corner, which should be sharp, and causing the teeth to mislock. When a tooth has traversed the impulse face of one pallet, another one should drop on the dead face of the other pallet, as near to the corner as possible without missing it. When the corner becomes worn, the teeth in dropping just miss it and fall direct on the impulse face, instead of being locked motionless on the dead face. This is termed mislocking. To remedy it, the wear must be buffed out of the impulse faces only, and the pallets closed in a vice (their control portion is generally soft enough to bend, and should first be tried with a file). Close them until the teeth just lock again. If the pallets are hard throughout, and cannot be filed anywhere, they must be removed from their arbor and softened in the centre before closing them. With care this can be done without softening the pallet faces themselves.

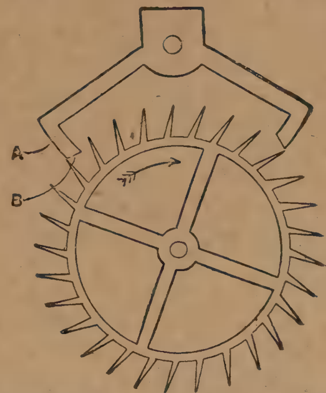


Fig. 24.—English Dead-beat Escapement

Or, like recoil pallets, when worn they may be moved on their arbor, etc. as already described; the same directions also apply as to topping the escape wheel, etc.

Testing a Room for Dampness

The following simple test for finding out whether or not a room or house is too damp to be healthy has been recommended; it is based on the property which certain bodies have of absorbing the water in the air—as lime, for instance: Take 500 parts (by weight) of lime, newly burned, not slaked or pulverised; place it for twenty-four hours on a plate in the room to be examined, with the doors and windows closed; at the end of this time weigh the lime, and if the weight has not increased more than by one part, the room may be declared habitable. If the weight has increased by 5 parts or more, the room cannot be inhabited without danger. The proper degree of hygrometry oscillates between 1 part and 5 parts more or less for inhabited places. The test is not suitable for very large or very small rooms, but is reliable for rooms of ordinary size.

Woodworking: Mortise-and-tenon Joints

Of all the different kinds of joints used in woodwork, the mortise-and-tenon group is by far the most important, besides being the most extensive in variety and adaptable to almost every case where strength and sound construction are desirable. A few of the leading forms which are likely to be of the most use to the amateur are treated in this chapter.

Figs. 1 and 2.—Plain Tenon

Plain, Simple Tenon.—A simple form of mortise and tenon is shown by Figs. 1 and 2, separated and together, while Fig. 3 illustrates the two parts of the joint set out. The thickness of the tenon is the same as the thickness of the wood, the shoulders being cut from the two edges instead of from the front and back faces, these being bare as it were, hence this joint has been called the "bare-faced tenon," but not correctly so, as in a true bare-faced tenon only one piece of wood is removed (at the back) to form the tenon. The mortise is a square or rectangular hole, the breadth of which is is made equal to the thickness of the tenon. This joint will be found useful in the construction of towel-horses and for similar purposes.

Closed Mortise and Tenon.—One of the most common forms of mortise-and-tenon joint is that known as closed mortise and tenon, which is shown, separated and together, by Fig. 4. As a general rule, the thickness of the tenon is one-third the thickness of the wood, but this sometimes has to be varied to suit circum-

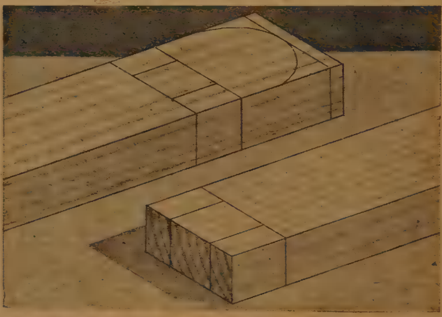
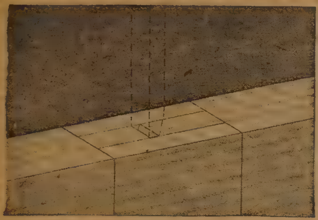
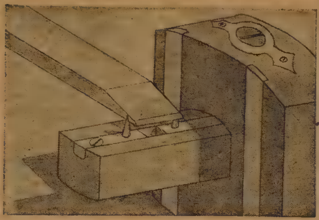


Fig. 3.—Setting out the Work Shown by Figs. 1 and 2

Figs. 6 and 7.—Gauging for Mortise and Tenon

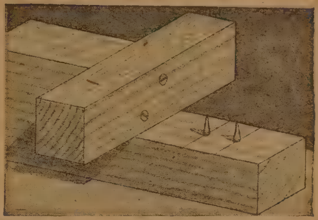


Fig. 8.—Improvised Mortise Gauge

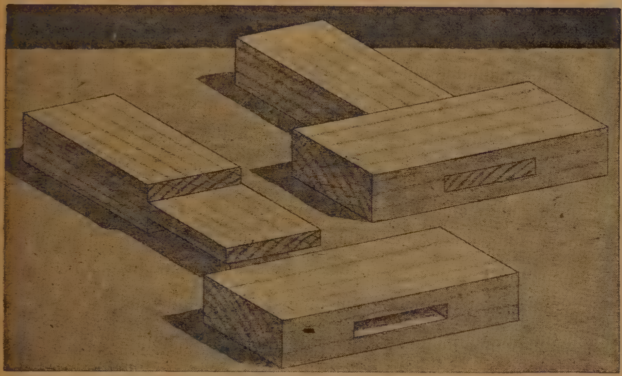


Fig. 4.—Closed Mortise and Tenon

stances. The setting out for this joint is shown in the upper view at Fig. 5, and the parts ready for fitting together in the lower view. In this, as in some other cases, a piece of waste is shown as being left on at each end; this waste is removed by sawing, paring and planing or shooting, after the joint has been fitted and fixed together. This is more often the method adopted, especially in making joints of articles. The other method, which, of course, has its advantages, is to true the ends by paring or planing, thus getting the several pieces to nearly a true length, which leaves very little to smooth off when finished.

Gauging for Mortise and Tenon.—Two gauge lines are usually required for marking out mortises and tenons. These may be made by driving in the chisel just the right distance from the face of the work, as indicated in Fig. 6;

Fig. 5.—Closed Mortise and Tenon: Two Stages

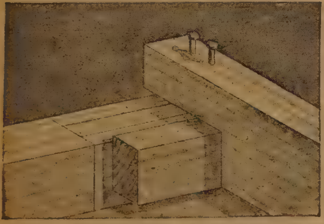


Fig. 9.—Using the Gauge Shown in Fig. 8

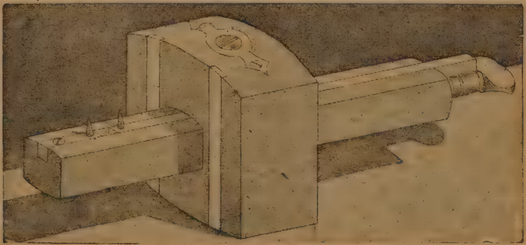


Fig. 10.—Mortise Gauge

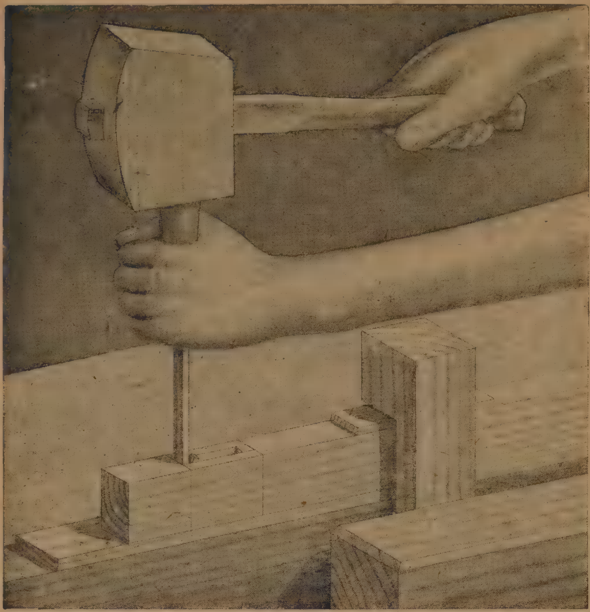


Fig. 11.—Using Mallet and Chisel in Mortising

then with an ordinary gauge set the tooth just to the near edge of the cut made, and gauge for one side of the mortise and tenon, next set the gauge so that the tooth just touches the far side of the cut made by the chisel, and gauge for the other side of all the mortises and tenons. A better plan is, of course, to have a mortise gauge, one kind of which is illustrated by Fig. 10. By loosening the set-screw in the stock this can be adjusted to any distance required, and the slide can be moved by means of the thumb-screw so as to regulate most accurately the distance between the teeth. The chisel should be just between the points of the teeth, as shown by Fig. 7. If there is much gauging for the same size mortise and tenon to be done,

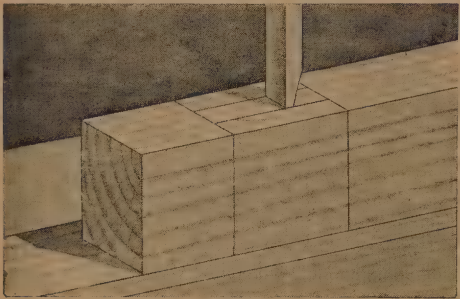


Fig. 12

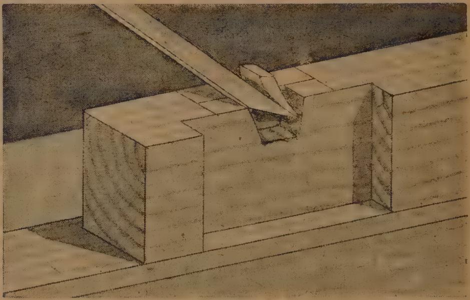


Fig. 14

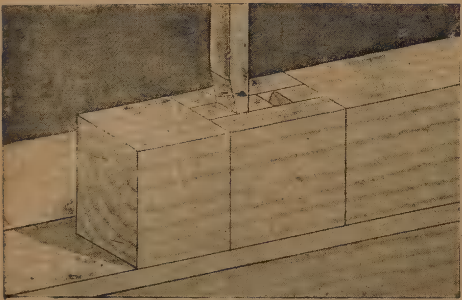


Fig. 13

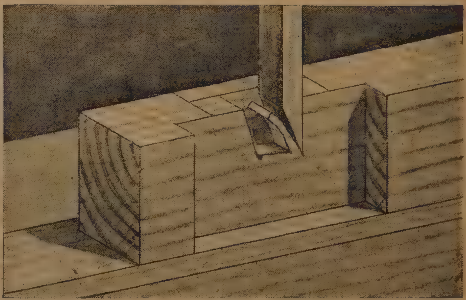


Fig. 15

Figs. 12 to 15.—First Four Cuts in Making Mortise

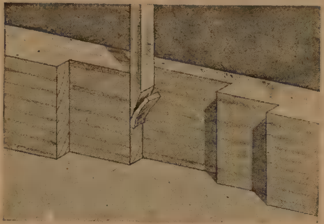


Fig. 16.—Mortise with Square Sides

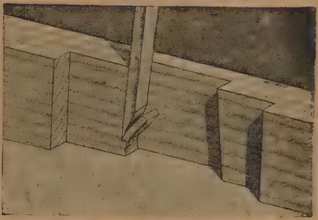


Fig. 17.—Mortise with Sloping Sides

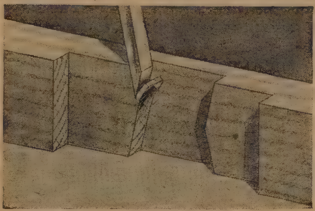


Fig. 18

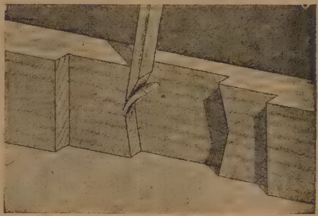


Fig. 19

Figs. 18 and 19.—Mortises with Irregular Sides

and if a mortise gauge is not handy, a simple improvised gauge for the purpose can easily be made with two pieces of wood and four or five steel sprigs, as will be understood by referring to Figs. 8 and 9.

Mortising.—Fig. 11 shows one position during the process of mortising, and a simple contrivance for holding the work whilst performing this operation. For the latter, it is best to get a piece of hardwood about 2 in. or $2\frac{1}{2}$ in. square and 10 in. to 1 ft. long, and cut out a piece so as to leave a head 3 in. or 4 in. long, and a stem $\frac{3}{4}$ in. to 1 in. thick. Then, when the work has been placed in position with a piece of waste under the head of the contrivance, the stem is securely fixed by tightening up the vice; and by giving a tap on the top of the mortising grip it will be found that the work is rigidly held.

Start the mortising by driving the chisel into the work with the bevel of the chisel towards the worker (see Fig. 12), then reverse the chisel so that the bevel is away from the worker (see Fig. 13), and drive in the chisel $\frac{1}{4}$ in. or $\frac{3}{8}$ in. away from the first cut. Then lever out the piece thus partly severed, as shown at Fig. 14. Proceed in the manner shown by Fig. 15. The finishing cut to each line should be carefully made just to the line, as indicated at Fig. 11. These operations are continued till the depth of the mortise is about one-half the depth of the finished mortise. Then turn the work over and repeat the process just described, from the other edge, taking care not to drive the chisel through the lower edge, in order to obviate damaging the arrises of the mortise hole on that edge. Figs. 16 to 19 represent four sectional views showing the front cheeks of the mortises cut away so that parts of the interior of the mortise may be seen. At Fig. 16 is shown the ends of the mortise cleanly and squarely cut through, this being done by holding the chisel square to the edge of the work as it is driven through. At Fig. 17 is depicted a common fault in mortising. It will be observed that the chisel has been

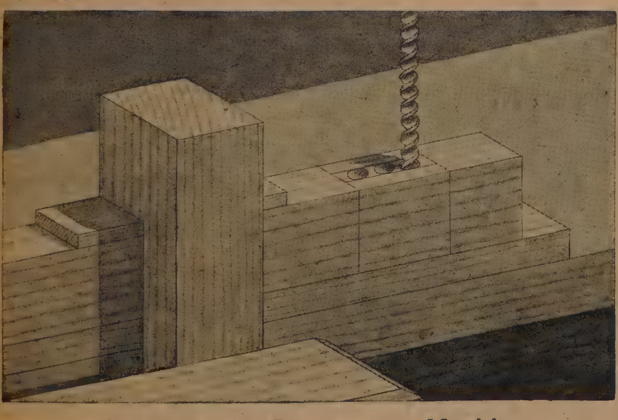


Fig. 20.—Boring Preparatory to Mortising

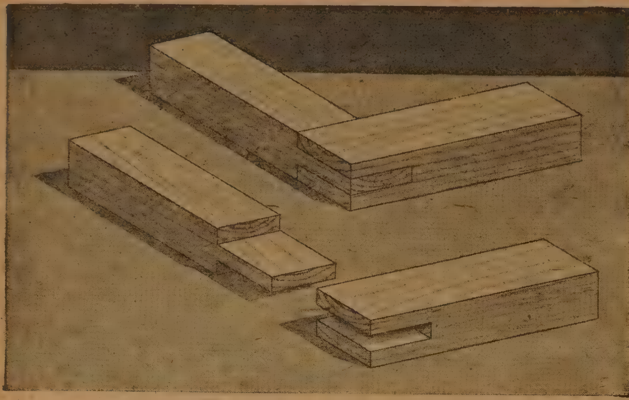


Fig. 21.—Open Mortise and Tenon

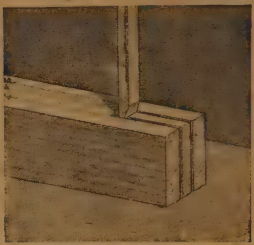


Fig. 23

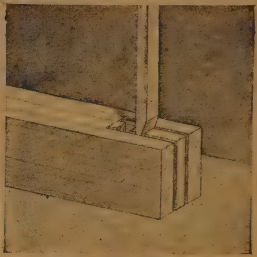


Fig. 24

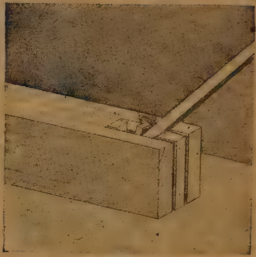


Fig. 25

Figs. 23 to 25.—First Three Steps in Removing Open Mortise Waste

allowed to "lead" in and has been driven right through from one side, causing the mortise to be too wide and rendering, very likely, the possibility of splitting out a piece. If the chisel were held in the opposite direction the result would be as shown at Fig. 18; the mortise would in this case, of course, be too narrow in the middle. The mortise shown at Fig. 19 would be objectionable, because it would be too wide in the middle, and if it were desired to wedge the joint, the wedges would only hold just the far and near ends of the tenon and leave the middle loose, as will be obvious.

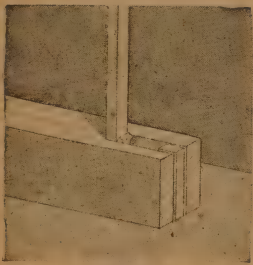


Fig. 26

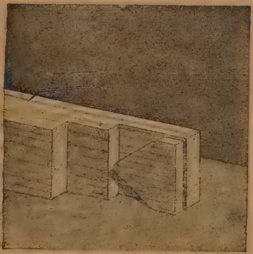


Fig. 27

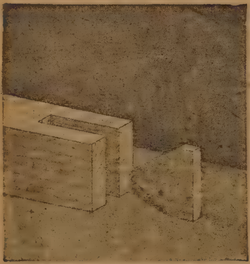


Fig. 28

Figs. 26 to 28.—Final Steps in Removing Waste

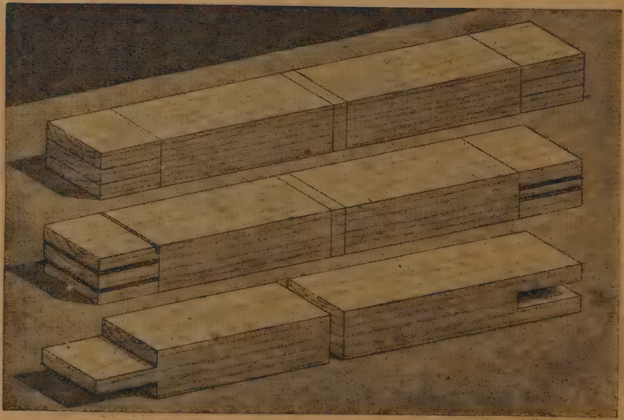


Fig. 22.—Open Mortise and Tenon: Three Stages

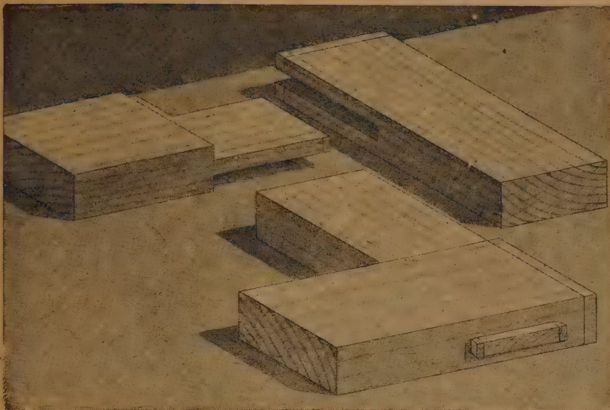


Fig. 29.—Haunched Mortise and Tenon Wedged

Boring Preparatory to Mortising.—Sometimes it will be found a good plan to bore several holes in the waste that has to be removed in order to form the mortise (see Fig. 20), this method facilitating the work of the chisel, especially when the mortise does not go right through the work. Of course, great care must be taken to see that the borings are not made too deep.

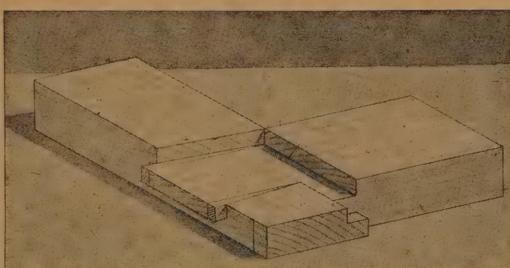


Fig. 30.—"Cut-away" View Showing Wedges

Open Mortise-and-tenon Joint.—This form of joint is especially suitable for joining the angles of light frames, etc., where the stuff is so small that there is not sufficient room for an ordinary or closed mortise-and-tenon joint. If the parts are made so as to fit together and are well glued, it will be found a much stronger joint than the angle-lap joint. Fig. 21 shows the parts separated and also the parts assembled, while in Fig. 22 this joint is shown in the three stages of execution. Both the mortise and the tenon are made partly by sawing, and great care has to be exercised to saw in such a way that the thickness of the tenon is left just the proper size. The whole thickness of the two kerfs must be taken out of the waste, in the case of the mortise, so as to leave the opening the full width. To mortise out the waste, place the cutting edge of the chisel about $\frac{3}{16}$ in. away from the line, as shown in Fig. 23, then drive it down about $\frac{1}{2}$ in. Withdraw the chisel and place the edge about $\frac{1}{4}$ in. or $\frac{3}{8}$ in. from the first cut, as indicated in Fig. 24, drive the chisel down, and then lever out the piece of waste. The appearance of the mortise when this is done is shown in Fig. 25. The edge of the chisel may next be placed just up to the line and then, holding the chisel vertically, drive it down about halfway through (Fig. 26), turn the work over, and repeat the process. The piece will then come

Fig. 31.—Haunched Mortise and Tenon: Two Stages

out and leave the mortise in the condition represented by Figs. 27 and 28.

Haunched Mortise-and-tenon Joint.—This joint is the all-important one for joining the corners of door sashes, frames, etc. It has a most extensive application. A common form is illustrated at Fig. 29, first in pieces; second, together. The tenon is wedged into the mortise. The position of the wedges will be clearly seen on referring to Fig. 30. The setting out for this joint is clearly shown in the upper view of Fig. 31, while in the lower diagram the parts are shown ready for

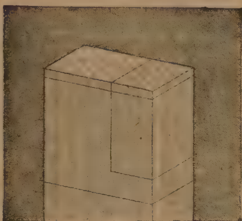


Fig. 34

Fig. 35

Figs. 34 and 35.—Preparing the Haunch

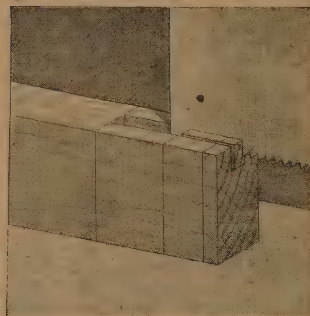


Fig. 32.—Sawing for Haunching

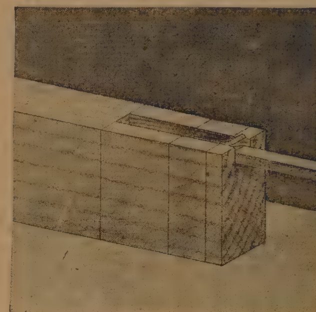


Fig. 33.—Paring for Haunching

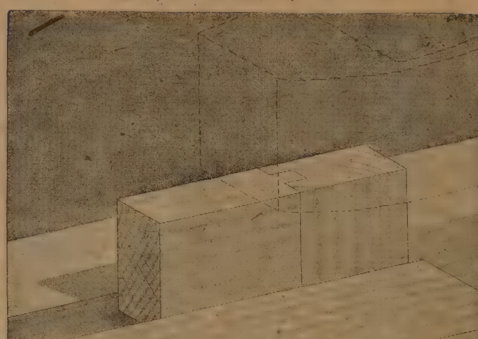


Fig. 40.—Planing End of Stile; note that the Direction of Planing is from the Outer Edge

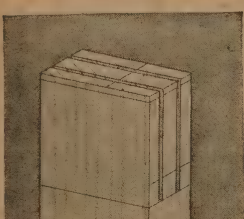


Fig. 36

Fig. 37

Figs. 36 and 37.—Another Method of Preparing Haunch

Fig. 38.—Stile Dubbed Off

Fig. 39.—Stile Badly Smoothed Off

fitting together. On the back of the piece that forms the stile there is a line beyond the mortise line on each side. The space enclosed between this line and the mortise line is the amount of the allowance for the wedges.

Making the Haunch. The simplest way to make the haunch in a joint like that just described is to use the end of a tenon or dovetail saw and saw down to the desired depth as shown by Fig. 32, and then pare out the waste with a chisel, as in Fig. 33.

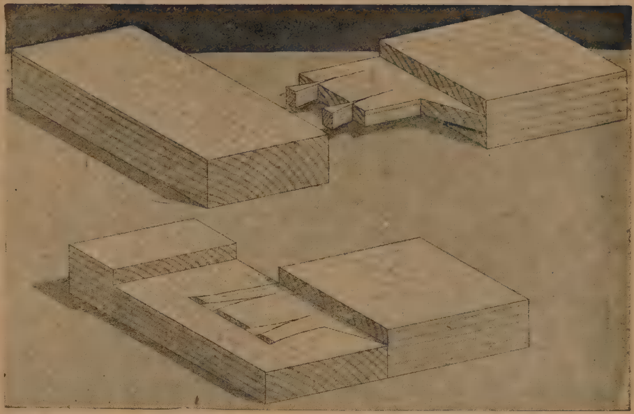


Fig. 42.—Secret Haunched Mortise and Tenon, Fox-wedged

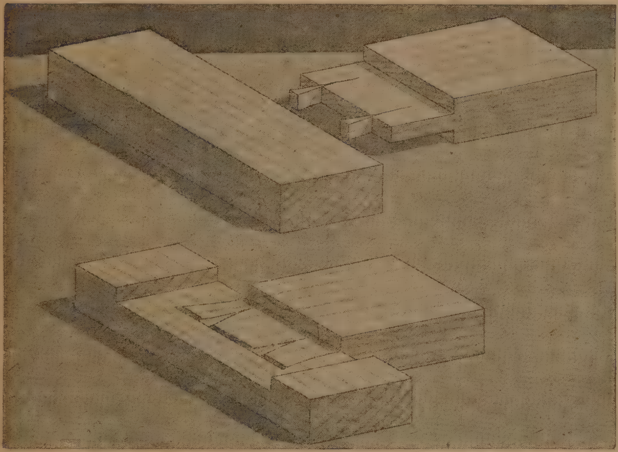


Fig. 41.—Fox-wedged Mortise and Tenon

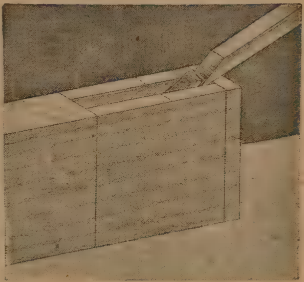


Fig. 44.—Preparing Secret Haunch by Paring

The Haunches of the Tenons.—The waste may be marked as shown in Fig. 34 and cut off, leaving the tenon piece as in Fig. 35. The gauging is then done, and the tenons cut, or the tenons may be cut first, as shown in Fig. 36; then, after the shoulders are cut, the haunching may be marked directly on the tenon, as shown in Fig. 37. The latter method is the best when small work is concerned and the former for larger work.

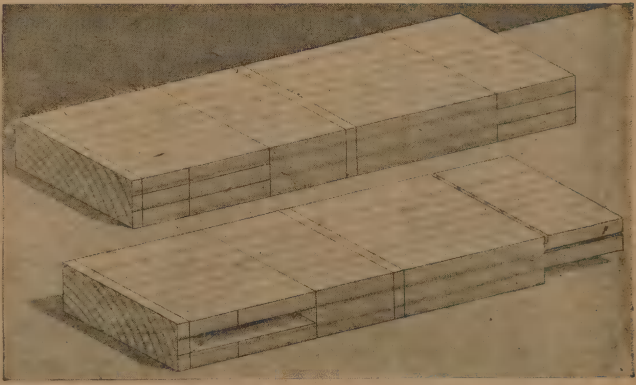


Fig. 43.—Secret Haunched Mortise and Tenon; Two Stages

Smoothing off.—Amateurs

often make good joints and then spoil them in smoothing off. When planing the end of the stile, as in Fig. 38, avoid taking too much off the outer edge, which results in making the end curve down as shown. Next, when truing up and smoothing off the faces keep the faces of the stile and rail in one plane. This is done by carefully watching and testing with a straightedge so as to avoid taking off an unnecessary amount of the outer parts, as shown in Fig. 39. When planing the end of a stile in a joint of this kind always do so from the outer edge, as indicated by the dotted lines which represent the plane at Fig. 40.

Foxed - wedged Tenon Joint. — It frequently happens that, when making articles which are to be stained and varnished and sometimes polished, it is desirable to have strong joints without the ends of the tenons being visible. One way of doing this is to make the mortise only two-thirds through the stuff and of a dovetailed shape inside (see lower view, Fig. 41) and the tenon slightly shorter. Then make two (or more) saw cuts in the tenon and place in these prepared wedges as shown. The parts should then be properly glued, forced up together with a cramp and by light blows with the hammer. As will be seen from the lower sectional view, the heads of the wedges are forced into the saw kerfs by the bottom of the mortise, thus obliging the wedges to spread out the tenon and causing it to fill the dovetailed mortise.

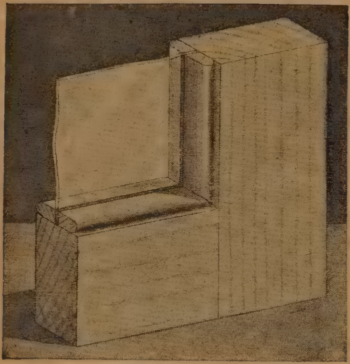


Fig. 45.—Glass Panel Held by Beads

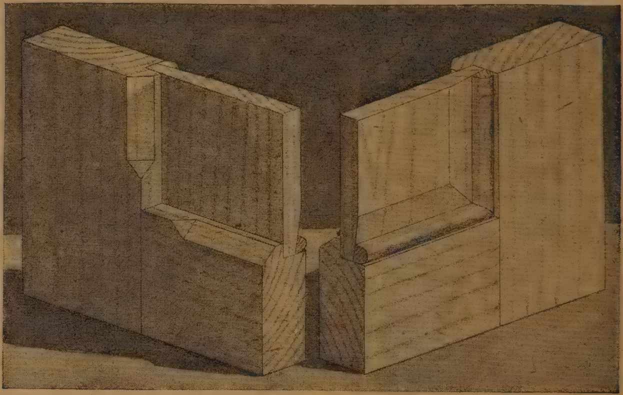


Fig. 47.—Wood Panel Held by Beads

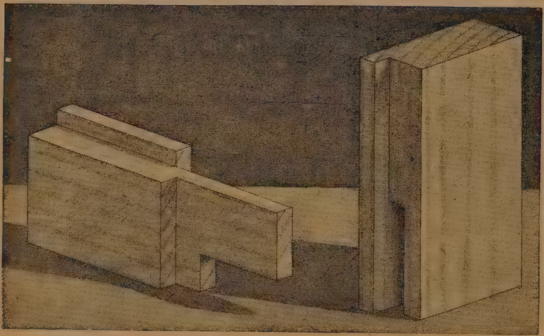


Fig. 46.—Stile and Rail Rebated for Panel

Secret Haunched Mortise-and-tenon Joint.—Sometimes it is undesirable to have a haunch which is visible when the work is put together. In such cases the form of joint illustrated by Fig. 42 may be used. The making of this joint is shown in two stages by Fig 43. The haunching is pared with the chisel, as indicated in Fig. 44.

Haunched Mortise-and-tenon Joint for Glazed Door.—Fig. 45 shows a haunched mortise-and-tenon joint as applied to one corner of a door for glass which, as indicated, is held in position by thin strips of wood, the outer edges of

which have been rounded: these are termed beads and are fixed to the stiles and rails with small sprigs. Another useful joint for the corners of small doors for glass or wooden panels is that shown at Fig. 46, where it will be seen that part of the inner edges are rebated, and the back shoulder of the tenon is cut longer so that it can fit into the rebate. The panel may be of glass, or of wood, which may be chamfered at the back so as to make it thinner at the edges as illustrated, and thus allow of a wider bead being fixed to hold it in position, as at Fig. 47. As there shown, the front of the framing can be much improved by chamfering.

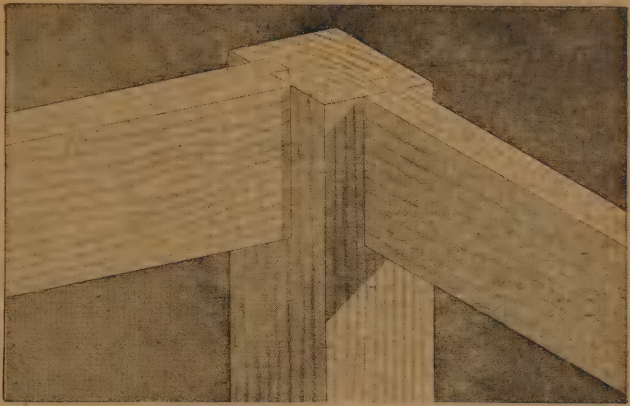


Fig. 48.—Part of Table Framework

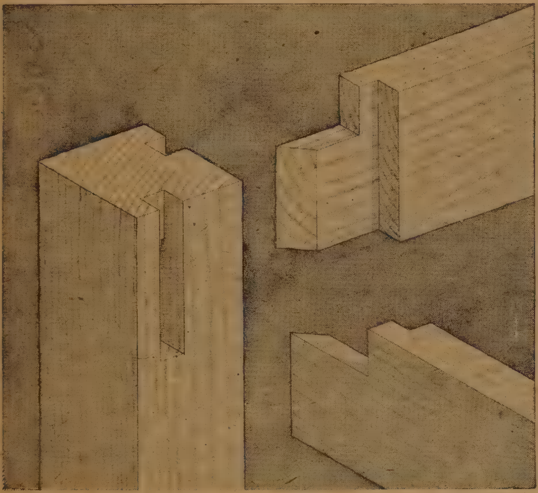


Fig. 49.—Joint Between Table Leg and Rails

Joint Between Table Legs and Rails.—Figs. 48 and 49 show a good form of barefaced tenon and haunched mortise-and-tenon joints for use on the rails and legs of a table. As will be seen, by the tenons not having a shoulder at the front they can be longer, also to gain additional length the mortises are made to meet, and the tenons are mitred as shown.

Haunched Mortise-and-tenon Joint for Panel Door.—Figs. 50 and 51 show one corner of a door in which the stiles and rails are ploughed—that is, so as to receive a wooden or other kind of panel.

Ploughing and Tonguing.—Where it is desired to insert panels in grooves made in the stiles and rails of doors, framing, etc., some form of plane known as a plough is necessary. One of the best kinds of these for general purposes is shown in use at Figs. 52 and 53. The

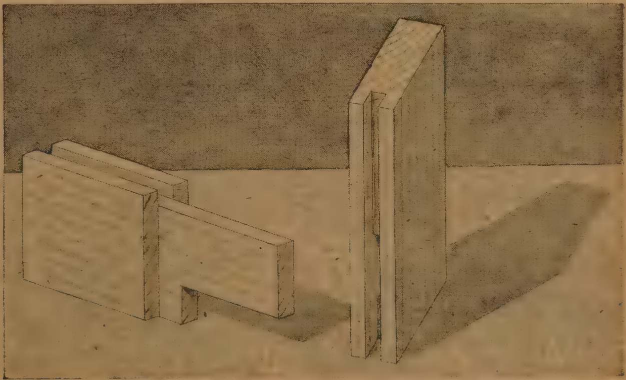


Fig. 50.—Rail and Stile Ploughed for Panel

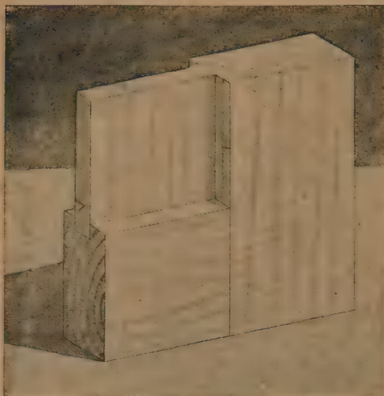


Fig. 51.—Panel Held in Ploughed Grooves

Fig. 52.—Holding the Plough

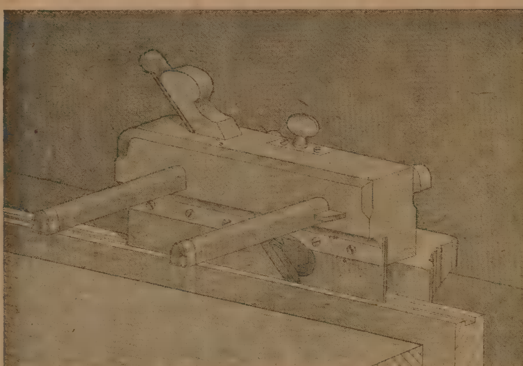


Fig. 53.—Using the Plough

Fig. 54

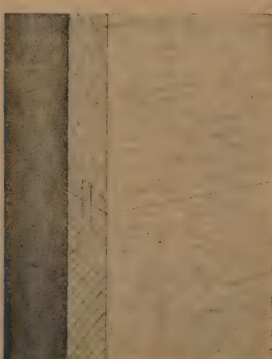


Fig. 55

Fig. 56

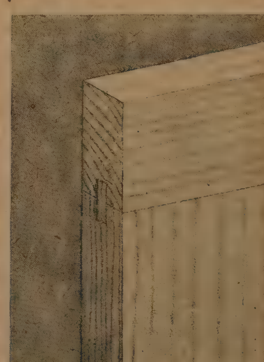


Fig. 57

Figs. 54 to 57.—Ploughed-and-tongued Joints

stock of the plane is held or released, and adjusted to the two stems, by two wedges, thus allowing the plough iron (the cutting iron) to be regulated so that grooves can be made any desired distance from the edge or face of the work against which the fence is pressed. By turning the thumb-screw head at the top, the gauge for depth is regulated. After the plough is set, the work should be fixed in the screw or some other arrangement so as to hold it fast; then, holding the plough in a similar manner to that illustrated in Fig. 52, begin working the plough at the far end of the wood to almost the proper depth, then gradually work back, and

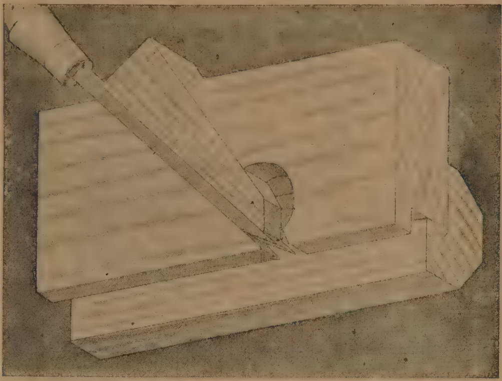


Fig 58.—Improvised Plough Plane

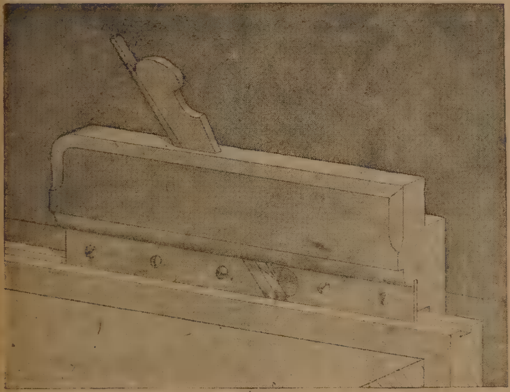


Fig. 59.—Grooving or Ploughing Plane

finally a push or two the whole length will produce a groove the proper depth.

Ploughing and Feather Jointing.—When it is desired to joint up boards lengthwise of the grain, so as to make table-tops and such-like examples, the edges are carefully planed with a trying plane so as to fit accurately, and each of the contact edges of the boards ploughed; then a thin strip of wood is prepared so that it can just slide in the groove, just slightly narrower than the combined depths of the grooves; this allowing for the joints on each side of the tongue coming close together, as shown at Figs. 54 and 55. The tongue may be a long strip with the grain going in the same direction as the boards, this being the general method.

Cross Feather Tonguing.—But a much stronger joint is produced if the tongue is made by cutting a piece equal to the breadth of the tongue across a thin board; as will be clear, the grain will be going at right angles to that of the boards and the tongue cannot split across its grain. These tongues are often known as cross feathers.

Clamped Ends.—To keep table-tops, drawing-boards, flaps, etc., from warping, the ends are often clamped; that is, a narrow piece of wood is carefully jointed to the end grain of the main piece, and then the end of the latter is ploughed, also that of the former.

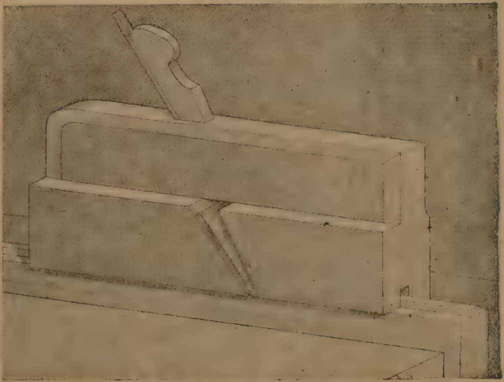


Fig. 60.—Tonguing Plane

Finally a straight or cross tongue is inserted, as illustrated at Figs. 56 and 57.

Improvised Plough.—The reader may not possess a proper plough, but he can easily improvise one as shown in Fig. 58, a chisel being used as a plough iron.

ploughing for small work. These planes are shown in action at Figs. 59 and 60, while Figs. 61 and 62 show how the fence parts of the planes fit the work. The general kinds of work for these planes are shown in Figs. 63 and 64, these illustrating

Fig. 61.—Fence Side of Tonguing Plane

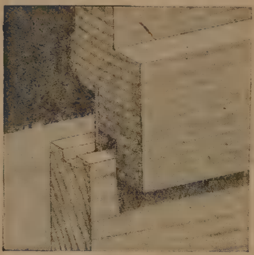


Fig. 62.—Fence Side of Plough Plane

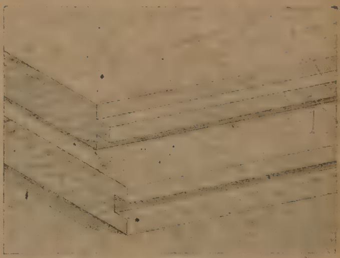


Fig. 63.—Groove-and-tongue Joint

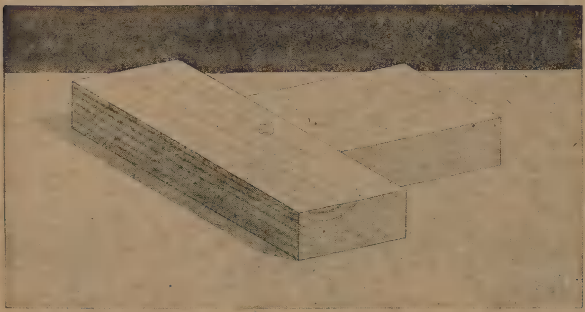


Fig. 67.—Joint Pinned or Drawbored

the ordinary straight jointing of boards. Figs. 65 and 66 show clamping, the tongue being worked on the clamp, this being easier than working the tongue on the end grain, but at the same time the latter is the stronger method. Of course, in the case of straight jointing and clamping of table-tops, pasteboards, flaps, etc., after the joints have been properly made

Fig. 64.—Groove-and-tongue Joint

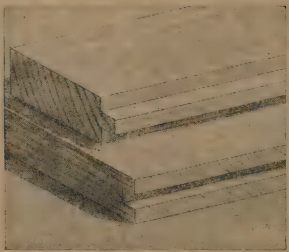


Fig. 65

Fig. 66

Figs. 65 and 66.—Groove-and-tongue Clamp Joint

Grooving and Tonguing or Match-jointing Boards.—When much jointing of boards has to be done, a pair of groove-and-tongue planes—or, as they are sometimes called, matching planes—will be found very useful; of course, the plough plane may be adapted to a variety of

they would be glued, and, if necessary, cramped up until dry, and then planed off true and smooth. But in examples of preparing boards, and grooving and tonguing them together for backs of cupboards, bookcases, and other work where match-boards are required, there

would not be any jointing up by gluing, the object being to allow each board to shrink or swell a little without being likely to split, which might be the case if they were all glued and the two outer edges fixed to the framing.

Pinning.—Sometimes it is preferable to pin joints—that is, to bore and, by the insertion of a wooden pin, hold the two parts of a joint together. One application of this is illustrated by the stub mortise-and-tenon joint shown in Fig. 67. After the joint is made and fitted, the parts should be cramped together (see Fig. 68), then bore a hole right through, and having prepared a wooden pin slightly conical and a little larger in diameter than that of the hole, drive it in so that it fits tightly, but take care not to split the work.

Draw-boring.—A simple and effective method of pinning—known as draw-boring—whereby little or no use for a cramp becomes necessary, is shown by Figs. 69 to 72. A hole is bored right through the two cheeks of the mortise—the tenon not being in the mortise; then the tenon is inserted, and with a sharp-pointed awl a little hole is made in the tenon against that side of the hole nearest the shoulder, as will be clearly understood by reference to Fig. 69, which is a sectional view showing part of the cheek of the mortise cut away. The tenon is now taken out of the mortise and placed on a piece

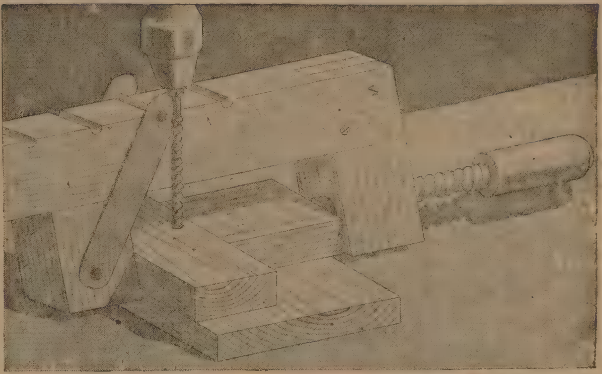


Fig. 68.—Joint Cramped for Boring

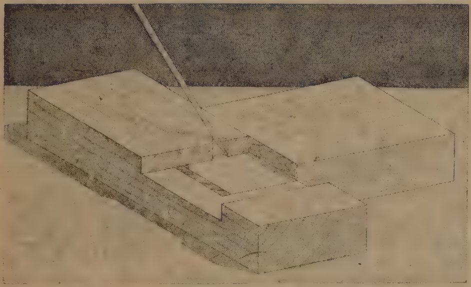


Fig. 69.—Marking Tenon for Boring

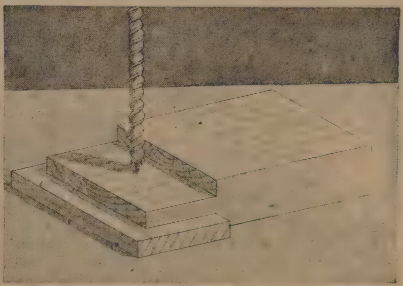


Fig. 70.—Boring Tenon

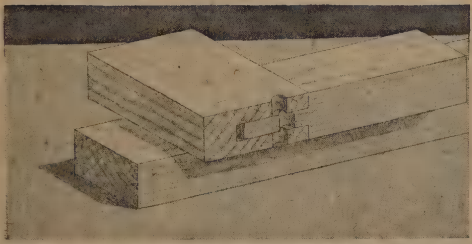


Fig. 71.—Relation of Holes in Two Parts of Joint

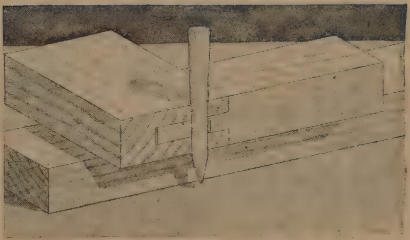


Fig. 72.—The Pin Driven In

of waste, and the point of a bit inserted in the hole made by the marking point, as shown in Fig. 70. The hole is then bored through the tenon. When the joint is put together the relation of the hole in the tenon and those in the cheeks of the mortise will be as clearly shown by the section view at Fig. 71. Upon the pin being driven in, the shoulders of the joint are drawn tightly together, as will be understood by reference to Fig. 72. The pin is then cut off at each side, and the joint smoothed, when it would have the appearance shown in Fig. 67.

Putting New Pins on Brooches

THE handyman is often asked to put a new pin on a brooch. The following is a convenient way when a proper pin is not forthcoming, and answers the purpose quite satisfactorily. Take a long ordinary pin, and with round-nosed pliers bend it to the shape shown at A in Fig. 1, taking care to leave an opening in the middle of the circle about the diameter of the pin itself. The easiest method of doing this is to bend the pin round a piece of wire of the right thickness, or round a stout needle stuck upright in the bench or table. There is no need to cut the head off, as it will not show from the front.

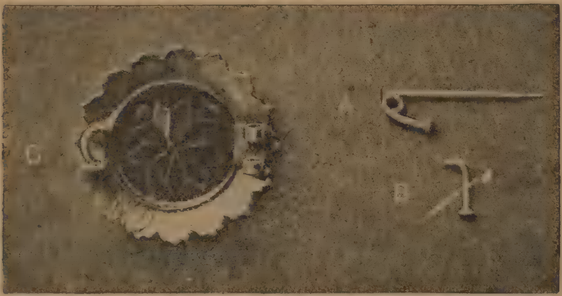


Fig. 1.—Brooch and New Pin Apart

Fig. 2.—Brooch Fitted with New Pin

Let it now be assumed that C (Fig. 1) is the brooch requiring a new pin. It will be noticed that there are two bearings, in which fits the small fastening that retains the pin, forming a hinge. If the old pin is broken, first remove the fractured piece by pushing out the fastening. See that the new pin fits properly between the bearings, and is long enough, then cut a short portion of a second pin and push it through the bearings and the circular opening in the new pin up to the head, finally bending over the end, as at B. Fig. 2 shows the same brooch fitted with a new pin in the manner described. The object of the short portion bent over at the bottom of the pin is to form a spring, to keep the pointed end from slipping out of the hook. The foregoing method is also applicable for fixing proper brooch pins, which may be cut from stout brass wire and filed to a point after bending, a short piece of the same wire serving to secure the pin in the bearings.

Simple Piano Repairs

In many houses is to be found an afflicted piano, whose condition, year after year, is allowed to go from bad to worse, either through carelessness on the part of its owner, or because the piano-tuner's estimate for repairs is considered too heavy. It may be an ancient "square" or "square grand," which is principally used as a sideboard, or it may be an old cottage pianoforte with an elaborate fretwork panel over the keyboard, either kind of instrument being as much out of repair as it is out of date. On the other hand, it may be a "Modern Upright Iron Grand, Over-strung, Under Dampers, and all the Latest Improvements," etc., etc., whose only fault—and a most annoying one—is that the loud pedal does not shut off properly. Whatever the kind of piano, it is the intention of this chapter to give such directions as will enable any intelligent home mechanic to overhaul the instrument and make it once more a source of pleasure to the hearers.

REPAIRING AN OLD "SQUARE" PIANO

The first class of piano to be described is the old "square." It is, of course, very much out of date, but with a little careful restoration the poorest specimen may be put into sufficiently good order to satisfy any not-too-critical performer,

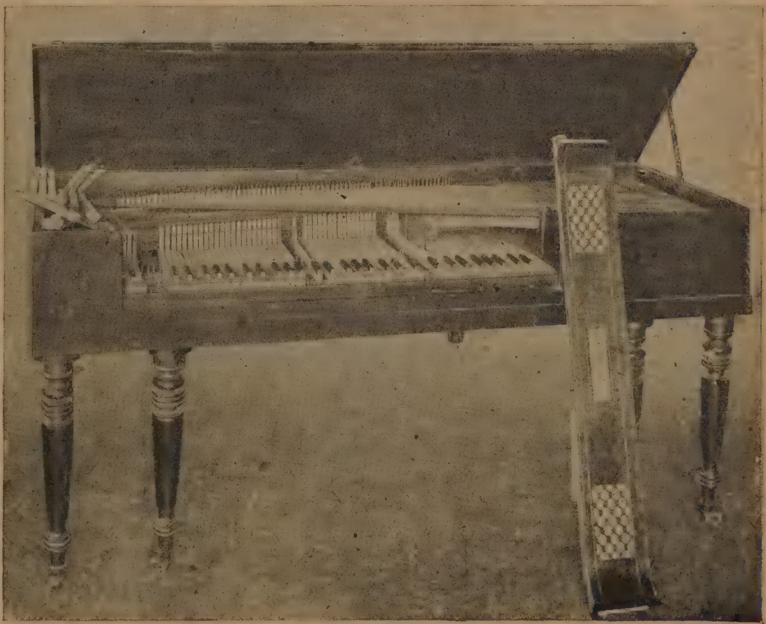


Fig. 1.—An Old Square Piano

and, with its light touch, it is an ideal instrument for children to practise on.

It has the advantage, too, of being often obtainable at a very low figure. Large numbers of these pianos, many of which deserve a better fate, are broken up every year by cabinet-makers and others for the materials of which they are composed, and one can sometimes be picked up for a few shillings.

Let it be assumed, then, that one of these old relics has been bought, and that the reader is desirous of restoring it to something like its original condition.

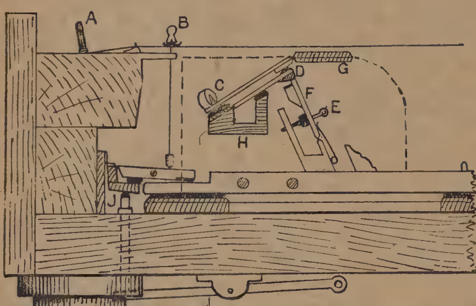


Fig. 3.—Action of Square Piano

Fig. 2.—Forming Eye on New String

Fig. 4.—Damper Felt

If it is intended to re-string it, the top of the piano should be removed entirely. The joint-pins of the hinges are usually made with a loop at one end, so that they can be drawn out easily, but in very old instruments it will be necessary to unscrew half of each hinge.

It is now possible to examine the interior of the piano. In all probability it will be found that several of the strings are broken, and that some of the hammers have parted company with their rail. The woodwork is hidden by a layer of dust and dirt, and all the baize and felt has been badly moth-eaten. Besides this, there are several little repairs necessary which will be described in due course.

By lifting out the name-board and the narrow slip of mahogany which runs along in front of the keys, the way will be clear for removing the action. The name-board simply drops into a couple of grooves. It generally fits rather tightly, but there should be no difficulty over this.

The action is usually made in two parts, separated by the partition supporting the sound-board.

In some of the earlier instruments the dampers, whose duty it is to stop the vibration of the strings when the keys are released, are fastened directly to the tail-ends of the keys. Each damper consists of a small wooden head with a piece of soft felt or cloth on the underside, and a threaded wire, which, after passing through a slip of wood let into the wrest-plank, is screwed into a little cylindrical piece of wood glued to the tail-end of the key. A little consideration will show that before the action can be removed it will be necessary to unscrew all the dampers and remove them. With the later actions, however, the dampers need not be touched unless they require repairing.

Now lift out a few keys at the ends and middle of the larger action frame, as shown in Fig. 1, and the screws which fasten it to the floor of the piano can then be seen. Remove these screws, and the whole affair should slide out with very little difficulty.

To avoid accidents in taking out the smaller action frame, carefully remove all its keys, and see that the hammers are free of the back edge of the sound-board. The latter will very likely have sunk slightly under the pressure of the wires, and it may even be necessary to wedge it up from underneath before the action can be removed. It will be well, before replacing the action frame, to see if the parts which jam can be shaved off a trifle, to allow of greater freedom.

Re-stringing.—Begin the work of restoration by supplying the missing strings. The most satisfactory job will be made by entirely re-stringing, except, perhaps, as regards the covered bass strings. There are two reasons for this.

The old wires, being usually rusty, are liable to break at any time, and the holes in which the wrest-pins should fit tightly are often so worn that there is great difficulty in getting the instrument to stay in tune.

Piano wire is sold by weight, and if the gauge (music wire gauge) of the strings is unknown, it is as well to show bits of the old strings as samples.

Beginning at the treble end, remove the first fifteen or twenty wires, unscrewing and withdrawing the wrest-pins by means of a tuning-hammer, which can be obtained for about half-a-crown. Do not take off more than this at a time, as, if all the wires are removed at once, there is danger of something giving way when the strain of the new wires is applied.

Lay the pins in a row as they are taken out and clean the dust and dirt off the sound-board with a damp rag. Now take the first coil of wire, draw out a sufficient length for the first note, and make an eye as shown in Fig. 2, by twisting the end of the wire round a headless wire nail driven into any firm piece of wood.

Hook the eye on to its correct hitch-pin, and cut off enough wire to allow three or four inches beyond the wrest-pin. Holding the latter in the tuning hammer, pass the free end of the wire through the little hole, and wind the surplus wire neatly round the pin, being careful to wind it on in the right direction. The pin must now be driven into its hole with a hammer, after being well rubbed with powdered resin to counteract any tendency to slip. Before finally tightening up the wire, see that it engages with its right pins on the bridges.

This process must be repeated until all the new wires are put on. In the earliest instruments the wrest-pins have no holes. In a case of this kind, soften the end of the wire in the flame of a lamp or candle, bend a short piece at right angles, and, laying it down the side of the pin, wind the rest of the spare wire tightly over it.

If a wrest-pin is badly worn, and shows a tendency to slip, cut a small V-shaped piece of fine glasspaper, and insert in the hole with the rough side towards the wood, before driving the pin home. Instead of this a new set of wrest-pins may be obtained at a small cost. It is advisable to use wire throughout a size or two smaller than the original wires, and to tune the piano a note or two below the normal pitch, as this considerably lessens the strain.

Now pass a strip of baize or coloured tape through the parts of the wires beyond the bridges, to deaden all sympathetic vibration, and the re-stringing will be finished.

Re-bushing Holes.—While the wires are off, see if the cloth lining is missing from any of the holes in the damper rail. If so, it will be necessary to re-bush them, in order to prevent an unpleasant rattling when the instrument is being played.

This is not such a difficult operation as at first sight would appear. Cut a narrow strip of cloth, and taper it to a point at one end. Now pass the point through the hole to be bushed and glue the cloth just above the hole. Pull it through until the glued part is in the hole, and when dry trim it off neatly. This method is also employed in re-bushing hammer-butts (see Fig. 7, p. 98).

Overhauling the Action.—The action (Fig. 3) is now overhauled. If any of the hammers are missing, new ones can easily be made, using mahogany or cedar, and taking one of the old ones for a pattern. Note that the hammer stems vary in length, those at the ends of the rail being rather shorter than the ones in the middle.

If the leather covering has become hard, it may be softened a little by brushing with a stiff brush. If, after this treatment, the tone is still unsatisfactory, re-cover the hammers with modern hammer felt, a length of which, of a sufficiently good quality, can be obtained for about a couple of shillings. It will be found that this felt tapers from one end to the other, the thickest portion being intended, of course, for the bass notes.

Cut the felt into strips a little wider

than the hammer-heads, and with a sharp knife bevel off each strip to the shape shown in Fig. 4. Lay the strips in order on some flat surface where they will not be disturbed while the old leather coverings are removed. Take the thickest strip, glue one side entirely except about $\frac{1}{2}$ in. in the centre where it goes over the nose of the hammer, and, with a piece of tape, bind it firmly over the head

Fig. 5.—Cottage Pianoforte

of the first hammer, being very careful not to strain the hinge. There will be less risk of this if the strip of wood covering the hinges is removed. Proceed in the same way until all the hammers are covered, and when the glue is quite dry cut off the tapes and carefully trim the felt, so that the hammers clear one another. The best way to do this is to slide the action into its place in the piano; then, beginning at the bass end, press up each hammer until it touches the wires, and mark the felt with a pencil or pen, allowing very little more than the width of the two wires. Then, on removing the action, the felt can easily be trimmed off to its correct dimensions. It will be necessary to cut a little off the left-hand side of each hammer-head, to clear the notches in the damper rail. The knife must be constantly sharpened, as the felt soon takes off the edge.

It may be found that, when a key is pressed down, the hammer blocks against the wires and prevents their free vibration. To correct this fault, unscrew the wire loop E (Fig. 3) until the hammer drops back again when it is within about $\frac{1}{16}$ in. from the strings.

The hammer hinges should be examined, and all damaged ones renewed. Each hinge has a tiny slip of wood glued over it to secure it to the hammer. Carefully remove this with a sharp knife, and fit a new hinge cut from a piece of vellum or thin leather.

Now overhaul the hoppers at the ends of the keys and the levers above them. Fit new hinges where necessary, and at the same time examine the little felt discs the hoppers rest against. If any are missing, supply new ones, which may be cut from a piece of cloth. All the working parts should be lubricated with a mixture of blacklead and tallow.

The dampers must now be taken in hand. New heads will be easily made, soft damper felt being obtainable from pianoforte supply houses. If the baize on the action frames, etc., is in bad condition renew it, but care must be taken that the relative positions of the hoppers

and hammers are not altered by using too thick or too thin a baize.

Fresh silk should be placed behind any fretwork, and the instrument will then be practically finished. Most of these pianos possess a "loud" pedal or its remains, but in some of the early ones loud and soft effects were produced by means of two levers operated at the left hand of the keyboard. In either case the mechanism is so simple that it can generally be easily repaired, should it be out of order.

If the instrument is unsteady on its legs the fault can be partly remedied by slipping cardboard washers over the screws of the legs which are in fault. If, however, the screws are badly worn, cut them off and fit fresh plugs of wood, which need not necessarily have a thread cut on them.

The methods of repair described may not, perhaps, meet with the entire approval of a professional piano repairer, but they have been the means of saving many instruments from destruction, and, if carefully carried out, cannot fail to give satisfactory results.

REPAIRING A WOODEN-FRAME COTTAGE PIANO

It may be that an old wooden-frame cottage pianoforte has come into the reader's possession—an instrument that has seen long years of service, and suffered all sorts of ill-treatment. First, turn back the top, and remove the fretwork front panel (see Fig. 5). This is usually secured by buttons, one at each end. Lift out the fall and name-board, and take out the bottom door. It may now appear that many little repairs are necessary. Some of the stickers are hanging loose, through the hinges of their levers giving way; others have broken away from the hammer-butts. A number of the hammer-shanks are broken, the heads having fallen into the bottom of the case, while sundry gaps in the row of hoppers show that these have shared in the general dilapidation. Add to this several broken strings, and it will be seen that a considerable amount of patience will be necessary to restore the instrument to anything like its original state.

Begin work by removing the damper rail and action. The former is held in place by a button at each end. Turn these, lift the rail and dampers out, and put them aside.

It is now necessary to take out the action, a rather delicate operation, as it is heavy, and if not carefully handled there is danger of breaking some of the hoppers.

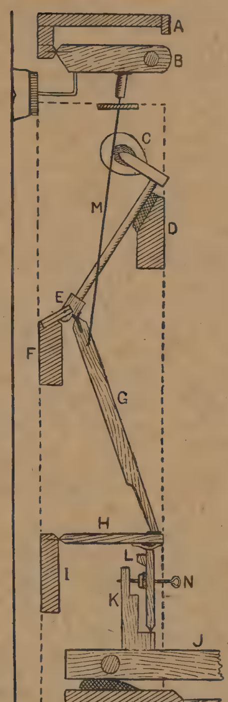


Fig 6.—Action of Cottage Pianoforte

Turn the buttons, and grasp the action firmly at each end. Pull the top forward a little, and lift out the whole concern. Having safely removed it, put it in a safe place, and the way will then be clear to replace the broken strings. Do this in the same way as in the "square" piano, first removing the old string, then forming an eye at the end of the new wire, cutting off a sufficient length, and winding it in the right direction on the wrest-pin.

If the wrest-pins fit tightly there is no need to take them right out, a few turns to the left, to free them of the old wire, being all that is necessary. Probably, though, they will be rather worn, and will have to be tightened in the manner previously described. At the same time examine all the other wrest-pins, and either tighten up the loose ones, or fit new pins a size larger.

It will be found that the different sizes of wire required are marked at intervals on the wrest-plank.

Fig. 7.—Re-bushing a Hammer-butt

In some instruments the treble notes will not keep in tune owing to the "bent side"—the curved piece of wood to which the lower ends of the treble strings are fastened—having pulled away from the bracings to which it is bolted and glued.

It is a rather tedious matter to correct this fault. To begin with, all the strings affected must be slackened, and the screws and bolts loosened. It will now be necessary to turn the piano upside down and strain the bent side away from its seating by means of wedges. Then pour plenty of good hot glue into the spaces, and work it well in with a warm knife.

The wedges must next be knocked out, and the bent side screwed back into place by means of as many cramps as there is room for. Replace the old bolts and screws, and, if there is room, fit one or two new ones. It should be left a day or two before re-stringing, to allow the glue to become thoroughly dry.

If the bent side is split, or badly worm-eaten, the simplest remedy is to fit a specially-made iron plate, with pins

Fig. 8.—Removing Hammerings

riveted to it, first of all, of course, removing the old pins. This can be obtained from a pianoforte supply house.

Restoring the Action.—Before beginning the restoration of the action it will be well to refer to Fig. 6, so that the principle on which it works may be thoroughly understood. It will be seen that when a key is struck the hopper K is raised, and pushes up the lever H, which, in its turn, carries up the sticker G. The sticker, being fastened to the hammer-butt by a flexible piece of leather, throws the hammer smartly against the strings. Without some special arrangement, how-

ever, the hammer would remain pressed against the strings until the key was released, and would prevent their free vibration. This difficulty is overcome by means of the hopper, which, when it reaches its highest point, "hops" or slips forward over the leather undersurface of the lever, thus allowing lever, sticker, and hammer to fall back.

To prevent the hammer dropping right back to its original position, a small cloth-covered block of wood L is glued at the back of each hopper, and this allows the note to be repeated very rapidly without the key rising to the level of its neighbours.

By means of the wire M the damper is

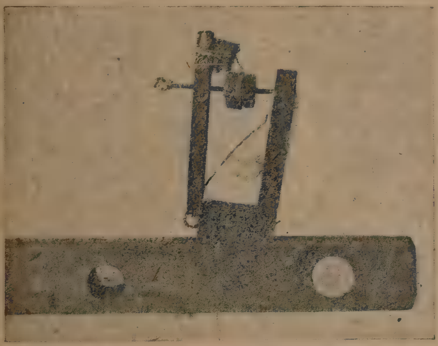


Fig. 9.—Broken Hopper

drawn away from the strings when a key is struck, and leaves them free to vibrate until the key is released, when it falls back into place.

In Fig. 6, A indicates damper rail; B, damper; C, hammer; E, hammer-butt; F, hammer-rail; I, lever rail; J, key; and N, regulating screw. The other letters have already been referred to.

This is the simplest form of action, but it has now been almost entirely superseded by the check action, which is more satisfactory in every way.

It will be better, perhaps, to begin at the top of the action and work downwards, so the hammers will be tackled first. Having found the heads of the broken hammers, sort them according to their size, and find their correct places. Now take one of the heads and the corresponding hammer-butt, and remove the pieces of the old shank, being careful not to damage head or butt in any way.

Choose a nice straight-grained piece of

Fig. 10.—New Hinge, etc., on Fly of Hopper

wood for the new shank, round it off neatly, and finish with glasspaper. Cut it to the correct length, and, using a rough, flat file, or a strip of glasspaper folded round a flat piece of wood, slightly taper the ends until they fit their respective sockets. In gluing one end of the shank into the hammer-head and the other into the butt, see that the head is the same height as the others, and that it is not twisted at all to right or left.

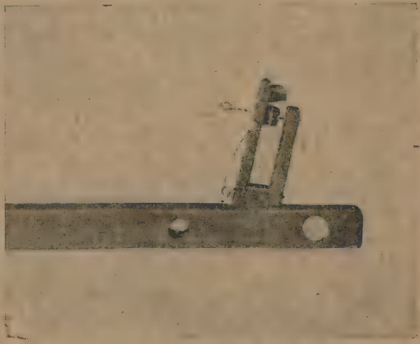


Fig. 11.—A Repaired Hopper

If the hammers have a lot of play, through the cloth lining the holes in the hammer-butts being badly worn, it is advisable to re-bush the holes in the manner already described (see Fig. 7).

It is not a difficult matter to remove the hammers, as they are threaded on a length of wire held in position by a long strip of brass which is notched to receive

Fig. 12.—Re-covering a Hammer: One End of Felt Secured

them. Both centre wire and brass slip are divided into lengths for convenience in repairing. Fig. 8 shows one section being removed.

The gluing of the stickers to their levers, or the leather hinges to the hammer-butts, will present no difficulty to the home worker, neither will the correcting of faulty damper wires.

To fit new hinges to the levers, carefully remove the old hinge, which fits into a slot in the lever and is glued to the lever rail, and supply a new one cut from a piece of vellum. It will be found convenient to use a pen-knife in removing the old hinges, the slot being sprung open a little, without splitting the wood.

With regard to the hoppers, new vellum hinges must be fitted where necessary in the same way as with the levers. While repairing the hoppers, see if any cloth washers are needed on the regulating wires for them to fall back against, and fit new springs if any are broken (see Figs. 9 to 11).

If it is decided to re-cover the entire set of hammers, this should now be done. Remove the old coverings by cutting them through at the point where they strike the strings, being careful not to touch the under layer of felt or cloth. Now cut the new felt into strips rather wider than the hammer-heads, and lay them in order on the table. These strips should be bevelled at each end, as was done in the case of the "square" piano.

In gluing them on, one end should be secured at a time with tape, as shown in Fig. 12. When this is dry, remove the tape, and bring the other end tightly round the point of the hammer, securing it in the same way. Finally, the felt, when the glue is thoroughly dry, should be neatly trimmed off with a sharp knife.

The dampers may now be overhauled, and new vellum hinges fitted where necessary. New felt will be an improvement if the old is in very bad condition.

Fig. 13.—Re-covering a Hammer: Other End of Felt Secured

The repairs being now practically completed the action may be replaced in the piano, and attention paid to its regulation.

If, when a key is pressed down, the

hammer blocks against the strings, the regulating screw N (Fig. 6) must be unscrewed (to the left) a little. When properly adjusted, the hammer should fall back when it is about $\frac{1}{16}$ in. from the strings. If any of the hammers drop back too soon, the screw must be turned to the right.

The directions given for removing the action and re-stringing a cottage piano also apply to instruments with check actions, with the exception that in the latter type the dampers and hoppers form part of the action, and are removed with it. This will be seen from Fig. 14. The check action, and especially that with under dampers, being a very complicated piece of mechanism, it is not advisable for the inexperienced man to attempt much in the way of repairs. Half the difficulty of repairing this action will be overcome by a close inspection of corresponding parts which are in good condition. New hammer-shanks may be fitted in the same way as in the cottage piano. It will be necessary first to undo the tape from the wire loop that holds it. Each hammer may then be unscrewed and taken out separately.

When fitting a new tape, the end of which is secured by the hammer-shank, do not remove the shank from the butt. Instead, make an incision in the butt with a small penknife, and press in the glued end of the tape with a blunt bradawl.

The cloth covering the pilot screws at the end of the keys is sometimes found to be badly worn, and should be replaced by fresh boxcloth cut into strips, and glued at one end only.

Do not forget that a little blacklead does wonders in the way of preventing wear and making things work smoothly wherever there is any friction.

Keys Sticking.—Great annoyance is often caused by keys or hammers sticking. This is usually the result of keeping the piano in a damp place, and the general remedy is obvious. If the fault is in the keys, see if the key pins have become rusty. If so, remove the rust with fine emery paper, and use a little blacklead afterwards to lessen friction. If the trouble is caused by the wood swelling, see if the holes are cloth-lined, and in that case press the cloth back a little with a smooth piece of steel. If the holes are not lined, they may be opened a shade with a small file.

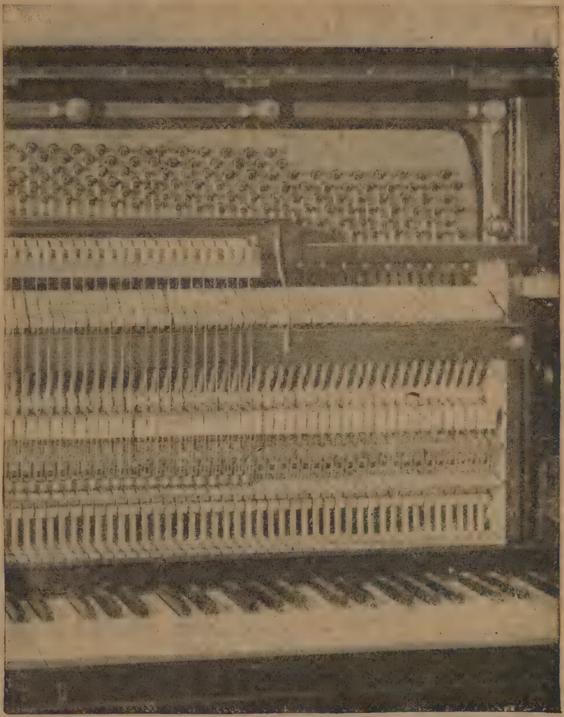


Fig. 14.—Treble Portion of Check-action Pianoforte

Hammer Sticking.—If the hammers stick, the fault is probably caused by the butts swelling. Try to free them first by working the hammers backwards and forwards. If this does not answer, unscrew the hammers, remove the joint wire, and open the hole a little by sliding a piece of smooth wire through it. Oil must on no account be used as a lubricant, as it causes the wood to swell.

Noises.—Unpleasant noises are sometimes heard when a piano is being played. "Buzzing" is a frequent trouble, and shows that some part of the instrument is loose. This is usually found in the sconces, but may be caused by some small part of the case having come unglued. The custom of placing articles on the top of the piano is often responsible for "buzzing." Again, it may be caused by what is called sympathetic vibration. That is to say, when certain chords are struck, loose articles in other parts of the room, such as gas globes, fireirons, etc., vibrate in sympathy. It should be a simple matter to locate this trouble.

Fig. 15.—Removing a Loose Pedal Nut

Squeaking.—The pedal action is another frequent source of annoyance. Squeaking is usually cured by treating all the working parts with a mixture of blacklead and tallow, and especially at the point where the pedal spring works on the rocker. The vertical pedal rod sometimes comes unglued; in re-gluing it, see that there is a piece of leather between it and the end of the rocker.

Adjusting "Loud" Pedal.—A common fault is that the strings keep on vibrating after the "loud" pedal is released. This is caused by the nut over the pedal being too loose, and consequently turning round when the pedal is used. To remedy this, obtain a nut with the same pitch of thread as the old one. Then, after adjusting one nut so that the pedal raises the dampers properly, screw the second nut tightly down on it with the aid of a pair of pliers or a small wrench. Another method is to close the hole in the nut slightly, using a small round-headed punch, and being careful not to damage the screw thread. Fig. 15 shows how a loose pedal nut is removed.

How to Re-hoop a Cask

THE life and utility of all kinds of tubs, butts, and casks depend on the condition of the bands or hoops, whose purpose is to hold and keep together the lags and their joints close. If the hoops become loose or lost, the vessel is to all practical purposes rendered useless.

A vessel made to hold water would not require its hoops to be as strong as one that is used to hold fermented liquors. All hoops on milk churns and utensils used for dairy purposes are best made of copper or galvanised hooping. Iron hoops on laundry tubs are liable to cause iron-mould.

Whatever the kind of vessel, or the kind of hoops to be used, the method of hooping is the same. Obtain from an ironmonger hoop-iron of the same kind and strength as the old hoops. This is

usually sold in laps, and by weight. The rivets should be bought (if a variety of tubs is to be repaired) in assorted sizes.

First straighten out the hooping. Pass a string round the cask in the same position as the proposed hoop will occupy when fixed; this will give the length of

Fig. 1.—Hoop Ready for Riveting

Fig. 2.—Method of Bevelling a Hoop

the hoop. Measure off on the hooping the length so found, and mark a line across the hooping with a slate pencil or a nail. To this add $3\frac{1}{2}$ in., which will be the amount required for the joint or lap. Within this $3\frac{1}{2}$ in. punch two holes to take the rivets; then bend over into the shape of the hoop, and mark through the holes already punched on to the other end of the hooping, and punch also.

The hoop ready for riveting is shown by Fig. 1. The holes can be punched through the hooping if it is laid on the end grain of a block of hard wood. But if a quantity of hooping has to be done, it is best to have a piece of flat iron drilled to suit the size of punch; a much cleaner job can then be made. Even a nut off an ordinary bolt can be used with good results, providing the hole of the nut is kept exactly under the punch when used. It should be observed that in any case the holes are punched from the inside to the outside of the hoops, otherwise it will be a difficult matter to drive the hoop on to the cask, besides causing a number of unsightly scratches on the side of the cask.

Having punched the holes, the rivets are inserted. The heads must be inside, and the riveting done from the outside.

If the hoop is now dropped over the end of the cask, it will be seen that it will fit at the bottom edge; but it will stand off at the edge nearest the top of the cask. To make it fit properly, it requires to be bevelled to fit the belly of the cask. This is done by expanding the bottom edge, the process being known as bevelling.

To bevel the hoop proceed as shown in Fig. 2. With the inside of the hoop uppermost strike with a hammer on the bottom edge of the hoop, turning the hoop evenly during this operation to secure uniformity of bevel. It can now be tried on the cask to see if it has been correctly bevelled; if not, it must be again hammered.

The hoop having been bevelled correctly, it can be driven on the cask. This can be done with a set hollowed to fit the circumference of the cask; or a piece of flat iron will serve (see Fig. 3), care being taken to drive it home equally all round. This can be ascertained by measuring from the top of the cask to the top of the hoop.

Fig. 3.—Driving the Hoop into Position

Vessels with a lot of belly on them, if exposed to the weather, often become loose during dry weather, the sun causing the timber to shrink, when the hoops begin to work upwards. This can be prevented by tightening up and driving a clout nail tight against the top edge of the hoop and into the cask. During severe frost, if exposed, the ice should be kept broken. If the water becomes a solid mass of ice, burst hoops will be a natural and almost certain consequence.

Hack-saws and Their Use

A HACK-SAW should form part of the outfit of every metal-worker, and it will soon repay for its cost. Much useful work, such as sawing iron and steel bars before turning, cutting bolts, cutting pipe into lengths, cutting off burrs that have been left on the ends of turned bars, etc., can be easily done with a hack-saw. It is often quicker to cut a metal bar by means of a hack-saw than in a lathe. When a piece of small turned work is wanted quickly, it is usual to leave an extra piece on the length, this extra piece being sawn off when the work is fitted in position, or when the correct length is obtained.

Fig. 1.—Lancashire Hack-saw Frame

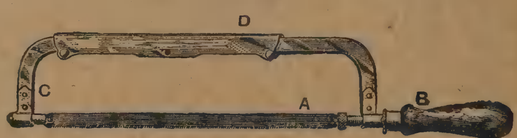


Fig. 3.—Sleeve-adjusting Frame

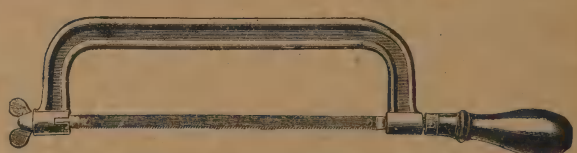


Fig. 2.—Cheap Cast-iron Frame

Fig. 4.—Solid-back Adjusting Frame

Hack-saw Blades.—Much work can be done with one blade. Some hack-saw frames are made so that they can be adjusted and used for different lengths of saw-blades, and many frames have an arrangement by which the cutting edge of the saw can be turned in four different directions, so as to cut in a downward, upward, or sidewise direction, as required.

Saw-blades are made with what are known as "hard" and "soft" backs. In the hard-back saw the whole of the blade is hardened, while in the soft-back saws only the teeth are hardened.

Soft-back saws can sometimes be bent to form a perfect semicircle without any damage being done to the blade, while most hard-back saws will fly into several pieces immediately an attempt is made to bend them. For this reason soft-back saws should generally be used, as they do not break when a side strain is put on the blade; should they become bent, they can be taken out of the frame and carefully straightened by means of a lead hammer or wooden mallet, the blades

being laid on a level surface while they are being struck.

Saws with either fine or coarse teeth are obtainable. The usual style of teeth is about twelve per inch, this being specially suitable for cutting soft steel, cast-iron, etc. Slightly finer teeth will be required for hard steel, while for tool steel, iron pipe, etc., still finer teeth will be required.

"Star" 9-in. blades are to be recommended. They are as hard as, or even harder than, a file. Those with coarse teeth (twelve to the inch) are used chiefly for gun-metal, copper, brass, and other alloys, while blades for cutting iron and steel have finer teeth, eighteen or twenty to the inch. No lubricant is required, as it only retards their cutting properties. When using the blades on iron or steel, a much slower stroke is necessary—not more than 75 to 80 per minute to obtain the best results. Any speed greatly in excess of this causes either the temper of the saw to be lowered or the teeth to be stripped. On the soft metals, a speed of from 120 to 140 strokes per minute will be found successful.

Types of Hack-saw Frames.—The frame illustrated by Fig. 1 is known as a Lancashire frame, and this type was generally used some years ago; but it is not a very handy pattern, owing to the fact that only one size of blade can be used. Another disadvantage is that the saw is riveted in, and difficulty is thus experienced in removing it. The blade can only be used in one direction—downwards.

A cheap form of cast-iron non-adjustable frame is shown by Fig. 2. This is a very strong appliance, and is quite suitable for a beginner. The blade can be turned in four directions.

The adjustable frame (Fig. 3) is preferred by many mechanics, owing to its strong construction. It will take saws from 8 in. to 12. in. long, and the blade can be turned to cut in four directions (see Fig. 5). The frame is adjusted for length by taking out the saw-blade A. This is done by unscrewing the handle B, and the frame at C is tilted downwards slightly in the sleeve D; this permits the frame to be extended or contracted.

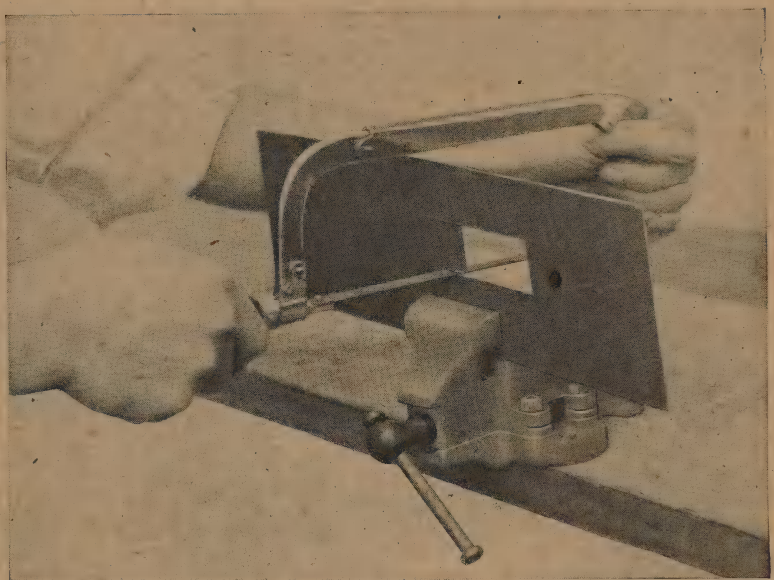


Fig. 5.—Sawing Sideways with Hack-saw

The type of adjustable frame shown by Fig. 4 is much used on account of its simplicity. It will take saws varying in length from 6 in. to 12 in., and the cutting may be done in four directions. When it is desired to change the direction of the cutting edge, the handle A is unscrewed, which permits the washer B (which has a pointed portion fitted to it)

and the end piece C to be revolved. When the frame is required to take a different length of saw, the washer D is partly revolved in one of the slots E. This washer has one side cut away, so that it does not reach the slots, and when it is in this position the short arm F can be moved along, and is fixed in position by turning the washer into one of the slots, thus preventing the short arm from moving. In this frame, and also in those shown by Figs. 2 and 3, the saws are simply slipped over short pegs which fit in the holes that are provided at each end. New saws can thus be quickly fitted.

Using a Hack-saw.—When using a hack-saw, the work should be fastened in a vice (unless too large) at about the same height as required for filing. The best height for this is nearly level with the elbow when the worker is standing upright. It is sometimes better, however, to have the work, say, 3 in. lower than the position required for filing.

The handle of the saw should be firmly grasped in the right hand, and the left hand should firmly hold the other end of the frame. The blades should be put in the frame so that they will cut on the forward stroke (away from the body). The saw should not be pushed forward either too fast or too slow. If it is pushed forward too fast, the teeth will slip over the work, and if pushed forward too slow the saw will jump badly. The happy medium will soon be found by practice; the amount of pressure to be applied will also be found in the same way.

No pressure should be put on the backward stroke (towards the body), and care should be taken to keep the saw-blade in a perfectly vertical position. Also, the saw should not be twisted sideways while being used; a hard blade subjected to such treatment would immediately break into pieces.

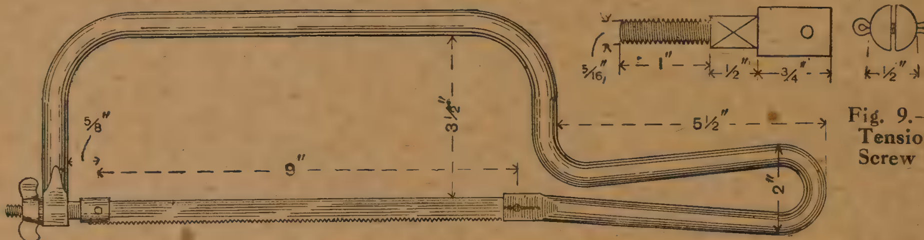


Fig. 6.—Hack-saw with Bent-steel Frame

Fig. 9.—Tension Screw

Fig. 7

Fig. 8

Figs. 7 and 8.—Front and Back Ends

Fig. 10

Fig. 11

Figs. 10 and 11.—Alternative End and Blade Socket

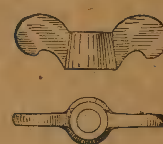


Fig. 12.—Winged Nut

Making a Hack-saw Frame. — The frame shown by Fig. 6 is suitable for 9-in. saw-blades, and is made from $\frac{1}{2}$-in. diameter round mild steel, of which a piece about 2 ft. 6 in. long will be required. First bend up a template to shape from $\frac{1}{8}$-in. diameter iron wire. Next take the $\frac{1}{2}$-in. diameter rod and swell up the end $\frac{1}{2}$ in. square. Then bend round the handle part and also the bow of the frame, leaving the tension end of the frame in the straight. Swell up this end square, and punch the hole as shown in Fig. 7; or it may be left solid and afterwards drilled and filed.

The blades in the frame shown in Fig. 6

are made to face four ways. This is a distinct advantage on right- or left-hand work, or in positions where the frame would be in the way were it not possible for the blade to be moved round one-quarter turn. This method of turning the blade is effected by cutting slots in the handle end of the frame at right angles to each other (see Fig. 8, which is an enlarged view). The blade can be inserted in these two slots, to cut four ways. Only of the blade. A $\frac{5}{16}$-in. winged nut for the tension screw is shown in plan and elevation by Fig. 12.

Simple Type of Frame.—A saw frame in its simplest form is shown by Fig. 13, a slot being formed in each end and holes drilled for the cotter pins. The frame has to be sprung in when inserting a new blade, therefore the distance between the cotter pin holes should be $9\frac{1}{4}$ in., allowing $\frac{1}{4}$ in. spring on the frame. This frame can

Fig. 14.—Front End of Non-adjustable Frame

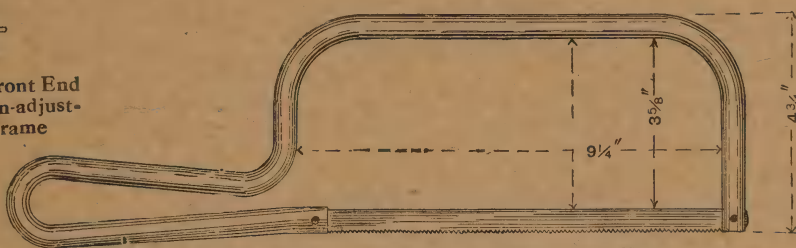


Fig. 13.—Simple, but Non-adjustable, Hack-saw Frame

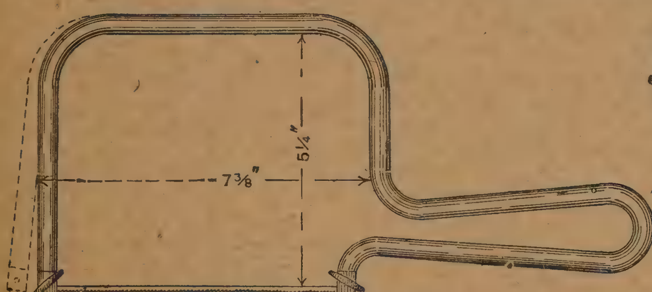


Fig. 15.—Piercing-saw Frame

Fig. 16

Fig. 17

Figs. 16 and 17.—Thumbscrew Device for Clamping Blades

one slot is required in the tension screw (see Fig. 9), the shank of which, being square, can be turned round and fitted in the squared hole of the frame to suit the new position of the blade. It will be advisable to drill the two holes for the $\frac{1}{8}$-in. diameter split cotter pin before the slots for the blade are cut (for details, *see* Fig. 8).

Another method is shown by Fig. 10; the handle end is bent round and provided with a square hole, as shown, to receive the blade socket (Fig. 11), which can be readily shifted to suit the required position be made to face the blade four ways by altering as shown in Fig. 14. This consists of filing a shallow flat on the sides of both ends of the frame, and then screwing in short wire pegs, on which the blade is hooked and kept taut by the spring of the frame. This method, although simplifying the construction, is not so satisfactory as that shown in Fig. 6.

Piercing-saw Frame.—The piercing-saw frame shown by Fig. 15 accommodates 6-in. fret-saws for metal. These small saws are useful for fretwork in sheet-metal, and also for model work.

The frame is made from $\frac{3}{8}$-in. diameter round mild steel to the dimensions given in Fig. 15 (p. 67).

The left-hand end of the frame should be shaped as indicated by the dotted line, so that when pressed in place to hold the blade it will have sufficient spring or resistance to keep the blade taut. Fig. 16 is a side view of the clamping arrangement for the blades, and consists of a small thumbscrew (Fig. 17) fitting in a plain hole in the loose clamp, and screwing to a tapped hole in the frame. The frames can be filed up, and finished by polishing with emery-cloth.

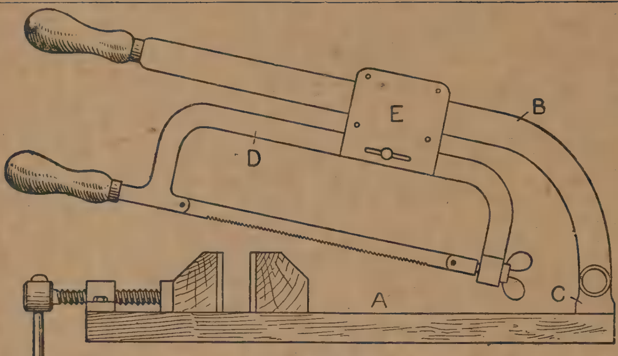


Fig. 18

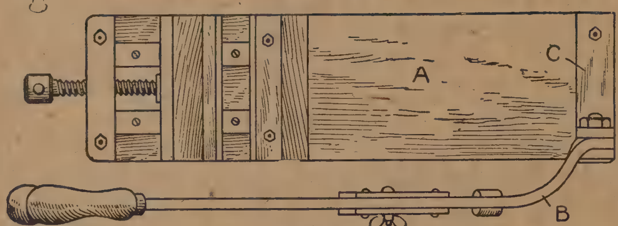


Fig. 19

Figs. 18 and 19.—Side Elevation and Plan of Hack-saw Attachment


Fig. 20.—Socket Plate

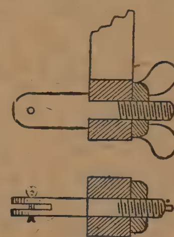


Fig. 21.—Back End of Frame

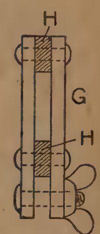


Fig. 23.—Coupling

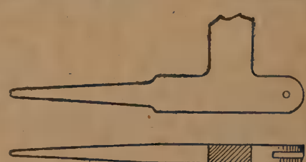


Fig. 22.—Front End of Frame

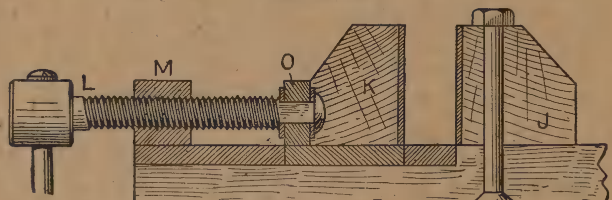


Fig. 24

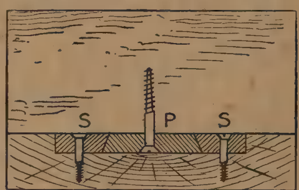


Fig. 25

Figs. 24 and 25.—Vice for Hack-saw Attachment

HACK-SAW ATTACHMENT FOR FIXING TO BENCH

Fig. 18 shows a side elevation, and Fig. 19 a plan, of a hack-saw attachment suitable for fixing to a bench. It consists of a hack-saw frame, attached to, and working on, a lever by means of a coupling. The lever is fixed to a wood baseboard, which is fitted with a vice at the front for holding the work to be cut. When in use, the pressure is applied with the left hand on the handle of the lever, the saw being worked with the right hand.

The baseboard A is of ash 1 ft. 10 in. long by 6 in. wide by $1\frac{1}{4}$ in. thick; the

wood used should be well seasoned, free from knots and shakes, and planed up true. The lever B is of iron or mild steel $1\frac{1}{4}$ in. by $\frac{3}{8}$ in. in section; it is fitted with a 5-in. turned wood handle at the front, and works in the socket plate C at the back, to which it is fixed with a $\frac{3}{8}$-in. bolt. The socket plate (shown enlarged by Fig. 20) is forged from iron $1\frac{1}{4}$ in. by $\frac{3}{8}$ in. in section, and is fixed to the baseboard with two $\frac{5}{16}$-in. bolts.

The hack-saw frame D is forged from mild steel $\frac{3}{4}$ in. by $\frac{3}{8}$ in. in section, for a 12-in. saw-blade. Fig. 21 is an enlarged view of the back end of the frame, showing side view and plan of the tension bolt, by means of which the saw-blade is tightened. The boss on the end of the frame is $1\frac{1}{4}$ in. in diameter, with a $\frac{3}{8}$-in. square hole through the centre for the reception of the spill of the tension bolt. The head of the tension bolt is $\frac{3}{4}$ in. by $\frac{3}{8}$ in. in section; the spill is $\frac{3}{8}$ in. square screwed at the end, and fitted with a fly-nut. A side view and plan of the front end of the frame is shown at Fig. 22. A spill $3\frac{1}{2}$ in. long is forged at the front, to which is fitted a 5-in. turned-wood handle.

The coupling E (Fig. 18), which works on the lever, and to which the saw frame is fixed, is made up as shown by Fig. 23. The sides G are $\frac{1}{4}$ in. thick, and the filling-up pieces H are $\frac{3}{4}$ in. deep by $\frac{3}{8}$ in. thick, the whole being fixed together with rivets. The slot formed between the sides of the coupling and the filling-up pieces should be of such a size as to fit and work on the lever. The saw frame is attached to the bottom of the coupling, and is then fixed in position by means of a bolt and fly-nut.

The vice in which the work is held is made up as shown at Figs. 24 and 25. The back jaw J is made of ash 6 in. long by $2\frac{1}{2}$ in. deep by $2\frac{1}{4}$ in. wide. It is protected on the face with an iron plate $\frac{1}{4}$ in. thick fixed with screws, and is fixed to the baseboard with two $\frac{3}{8}$-in. bolts. The front jaw K is 6 in. long by $2\frac{1}{2}$ in. deep by $1\frac{3}{4}$ in. wide, and is protected on the face with a $\frac{1}{8}$-in. iron plate. The screw L is $\frac{3}{4}$ in. in diameter, fitted with a handle $\frac{3}{8}$ in. in diameter, by means of which it is turned. The screw works through the nut M, which is $1\frac{1}{4}$ in. wide, fixed to the baseboard with two $\frac{3}{8}$-in. bolts. The end of the screw passes through an iron plate O, which is 6 in. long by $1\frac{1}{4}$ in. deep by $\frac{1}{2}$ in. thick, fixed to the front jaw with screws.

The end of the vice screw is well riveted over at the back of the plate O, iron washers intervening, as shown in Fig. 24. A guide for the front jaw of the vice is formed as shown in Fig. 25. The baseboard is boxed out 4 in. wide by $\frac{3}{8}$ in. deep, and two iron plates S, 1 in. wide by $\frac{3}{8}$ in. thick bevelled off on their inner edges, are fixed to the base with screws. An iron plate P is fixed to the bottom of the front jaw, fitting in between the two plates S, forming a guide for the jaw, and keeping it in position when worked.

Levelling Chairs and Tables

In most homes there is a chair or a table that rocks slightly when in use, this defect being caused by inequalities in the heights or lengths of the legs resulting from the use of "green" timber originally, from faulty construction, from the effects of wear on a stone or brick floor, or from unfair use. Correction of the defect is not a matter of difficulty and ought always to be undertaken. Be it remarked, a *three-legged* table or stool never rocks—any object can always be supported solidly on three points; and by applying this well-known fact, it will be seen that if only one leg of an uneven chair or table is altered — either shortened or lengthened—the article will stand firm, although the top or seat, as the case may be, may not necessarily be level.

The article of furniture needs to be tested by standing it on a flat surface; and in the case of a chair it can conveniently be stood on a table. It is useless to test the furniture on an uneven floor; and it may here be remarked that a frequent cause of rocking is not a defect in the furniture, but differences of level in the floor.

Fig. 1.—Method of Levelling Chair Legs

Confining attention for the time being to a chair that it is desired to level, it should be stood on a true table-top and rocked with the hand to see whether it will stand level on any three legs. If it will, the fourth will need to be lengthened with a piece of wood glued and nailed in position and afterwards trimmed and finished to match the chair leg. Cutting is generally regarded as being easier than lengthening; and for this purpose four blocks will be required, with three of which the chair is raised until it stands firm and level. Assuming, first, that these blocks are all of the same thick-

ness, the fourth one, yet unemployed, is placed *against* the remaining leg (as in the lower right-hand corner of Fig. 1), and with its assistance and by means of a sharp point, such as a penknife or a ground knitting-needle, a line is scribed completely round the leg. When the leg has been cut with a fine saw accurately to the scratched line the chair will stand firmly on any true surface. But, as before remarked, although firm, it is not necessarily level. In attaining that object, it might have been necessary to use packings of different thicknesses, as in Fig. 1; to use, for scribing, a piece of wood of the same thickness as the thickest of the packing pieces, and then to scribe and cut two or even three legs, instead of one, as in the former case. This will be better understood, perhaps, from a study of Fig. 2, which shows a table temporarily packed up for scribing. It is assumed that testing with a spirit-level laid on the top of the table in two or three directions has demonstrated the need of a thick packing at D, not quite so thick a one at C, a thin one at B, and none at all at A. Thus the last-mentioned leg in the longest and the first-mentioned the shortest; therefore, A will need to be shortened most and D will be left alone.

The method of scribing shown in Fig. 2 is of interest. A sharp nail is inserted through a scrap of wood at about the height required, any necessary adjustment being obtained by means of light taps up or down with a hammer. The point may be further sharpened with a file if desired. The result is a scribing block on the principle of that used by engineers.

Fig. 2.—Method of Levelling Table Legs

To get a really good result the scribing needs to be very carefully done, carried right round the leg, and the saw cut kept accurately to the line; for, if the cut be made at the wrong angle, one edge of the cut surface would be higher or lower than required, and the chair or table would still be liable to rock slightly.

Making Small Castings in Metal

THERE are numberless small articles, useful and ornamental, which are easily cast in metal at home. Panels for cabinets, copies of old medals, tokens, keyhole plates, knobs, feet, drawer-handles, etc., can be made at a trifling outlay. For small objects of a purely ornamental nature, type metal is the most convenient, being easy to melt, running well, and reproducing every detail of the mould, as, unlike most other metals, it expands in the process of cooling, due to the admixture of antimony it contains. Simple designs with no undercutting may be readily cast from plaster moulds, care being taken to see that the angles of the model are sloping enough to allow of the casting lifting easily. In foundry parlance, the "model" is known as the "pattern."

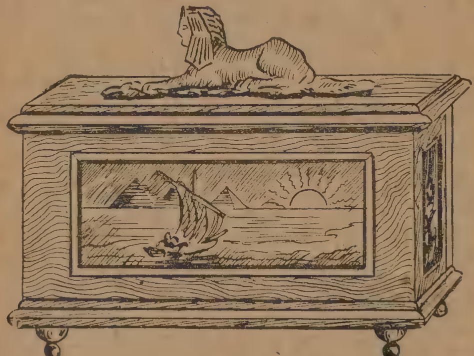


Fig. 1.—Oak Cabinet with Metal Panels

Casting a Panel.—Fig. 1 illustrates a casket, made of unpolished oak with an oil finish, the sides and ends being ornamented with panels in slight relief cast from type metal, the figure of the sphinx on the lid being also of this metal. All these can be modelled first in clay, then a mould made in plaster-of paris, and a casting made from this in type metal, the effect in contrast with the plain oak being very rich, as the panels resemble old silverware. In making the clay model, avoid undercutting, and make all the incised lines V-shaped, so as to enable the cast to lift easily.

The mould when ready for casting should be well coated with powdered plumbago (blacklead) thoroughly worked into all the cavities, and, to insure the metal gaining access to every part, the mould should be made fairly hot before pouring takes place. Of course, in casting a metal panel, there must be a wood frame encircling the plaster mould, so as to determine the thickness of the casting, and whatever packing is necessary can be done with a little clay.

The cleanest method of casting is to make a wood box of thin material exactly the size of the panel, which latter forms the bottom of the box, the lid closing down so as to leave only about $\frac{1}{8}$-in. space between it and the mould, which, of course, determines the thickness of the casting. When placed on end, pouring should be done from a hole in the end of the box, a small clay or cardboard

funnel being used to guide the stream of metal, and a few pinholes in the corners of the box will be sufficient for the escape of air, etc.

Casting a Figure.—Fig. 2 is a sectional view of the mould necessary for

Fig. 2.—Mould for Casting Sphinx

the figure of the sphinx, in which the model is placed on a flat-surface glass or tile, and the plaster heaped up until it covers exactly halfway (see the vertical line). The plaster is confined to this area by packing up the other side with clay, and after the first side of the mould is set it is taken off, cut to a clean lifting surface, and a few holes bored to make it key with the other side of the mould. After this is done the half is well oiled, replaced on the model, and the second half built up to its edge as illustrated.

To cast from this mould, the interior is well rubbed with plumbago, the two halves are tied together, and when inverted the metal is poured in from what

Fig. 7

Fig. 8

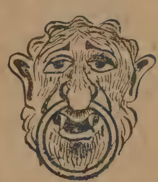


Fig. 9

Fig. 10

Figs. 7 to 10.—Drawer Handles

constitutes the base, pressing the surface of the metal while still soft with a smooth board so as to obtain a level surface.

This figure could also be cast hollow by the process described later (see p. 74) as "Cire perdu," undercutting being then no inconvenience.

Objects of this description are improved by filling the crevices with a mixture of lampblack and boiled oil, and then polishing all the prominent parts with metal

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Figs. 3 to 6.—Keyhole Plates

polish; this brings the modelling into strong relief.

Casting Keyhole Plates.—Figs. 3 to 6 show the possibilities of what can be done in keyhole plates, Figs. 4 and 6 being the end views of the respective castings. The models for these may be done in clay, wax, or plasticine, avoiding all undercutting and keeping the engraved lines open. The key-way should be cut or modelled at an angle (as shown by the slanting lines in the side section) so as to lift out easily.

Handles and Feet.—Figs. 7 to 10 show examples of what can be done in handles for the drawers and doors of cabinets, the rings being, of course, added

Fig. 11

Fig. 12

Fig. 13

Figs 11 to 13.—Cabinet Feet

after the casting is done, and holes for their reception drilled through part of the nose. Figs. 11 to 13 are designs suitable for feet for stands and cabinets, and are given to show the large range of possibilities of this interesting art.

Casting in Waste Moulds.—A waste mould is a mould that must be destroyed in releasing the cast. The casting of natural objects by means of such moulds is a simple method of obtaining metal replicas of fruit, plants, insects, and any small bird or animal. In the mould shown by Figs. 14 and 15 the object is an ear of wheat, and if care is taken, a copy, perfect in every detail, may be readily cast in type-metal or any of the easily fusible alloys. Any model that can be burnt may be used.

Take a cardboard box large enough to hold the object when embedded in plaster, as shown at A (Fig. 14). The model is supported on the tapering wood peg B,

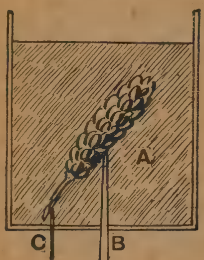


Fig. 14.—Model (Ear of Wheat) Surrounded by Plaster

Fig. 15.—Model Burnt Out to make a Mould

which is thrust through the bottom of the box, the peg, when withdrawn after the plaster is set, forming the gate by which the metal is run in. The first step is to push B through the bottom of the box far enough to support the model well away from the sides, and to the top of this peg the object to be cast may be affixed by a spot of glue or wax. C is a tapering piece of steel wire, part of a knitting needle will do, which is also pushed through the bottom of the box when the object is in position. This wire should just touch the lowest part of the object, and when withdrawn forms the riser for the casting.

Having got the object and the two pegs into position as seen in Fig. 14, those parts of C and B that are inside the box should be painted with a little oil or thick soap solution, so as to enable them to be easily withdrawn from the plaster. A thin plaster is now made of 1 part of plaster-of-paris and 2 parts of fine brickdust mixed with water, and this is carefully poured in until the model is covered up to the shaded portion as shown. In filling in this plaster, it should be well worked into the details of the model with a camel-hair brush, so that no air spaces are left and all the interstices are filled, and should then be allowed to set. When hard the pegs C and B are withdrawn, and the mould first gently dried in an oven, and then heated up until the model is completely burnt, the ash being blown out through the channel B by blowing through C. As some difficulty is found in reducing the object to ashes, it is advisable to soak it previous to casting in a strong solution of saltpetre, which, after drying, causes it to burn away freely, leaving only a slight residue of white ash.

Fig. 15 shows the mould reversed ready for casting, a basin-shaped cavity being cut away at B so as to take the fluid metal, while the small channel at C allows the air to escape, and when full of metal shows the casting to be complete.

When the metal is cold, it only remains to break the mould and to cut away the waste metal formed by the dead end at B and the riser at C, when a delicate copy of the model should be the result. Using the two pegs as described will be found a better method than suspending the objects by means of string, and the ashes are also blown out much more easily.

The "Cire perdu" Process. — A process of casting much used by the old Italians for their statuary is known as "Cire perdu." A waste mould is used, but only a thin shell of metal is cast round a central core. The model, which is of clay, is slightly smaller than the casting required, and the fine details are not worked out on it. The example in Fig. 16 shows an elephant A on a base, and the entire model has a coating of wax B given to it of the same thickness as the casting is required. This wax layer,

which may be produced by immersion in a bath of molten wax, receives all the finishing touches of the modeller, such as the fine creases and folds in the skin, hairs, and the markings of the eyes, etc., and the wax coat extends quite down to the bottom of the base, as shown by the thick line C. During the modelling of the base, four strips of sheet metal are embedded, one on each side, half of each being left projecting so as to engage with the sides of the mould (see E, Figs. 16 and 17). This is important in order to keep the central core at a fixed distance from the walls of the mould.

Having coated the model and given all the finishing touches to it, the bonds E are scraped free from wax and the tip of the trunk as well as the extremity of

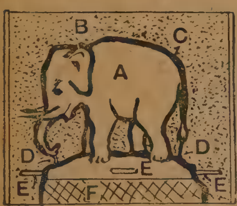


Fig. 16.—Model Covered with Wax and Plaster

Fig. 17.—Model and Mould Reversed for Casting

the tail are connected by two small wax bonds to the base (see D). This allows the metal to feed in at these points, while it also helps to drain away the melted wax. The entire model is now placed on a board between four retaining walls, a cardboard box serving this purpose excellently, and a mixture of brickdust and plaster made into a thick cream with water is run in until the model is covered. After the plaster has set firmly the mould is reversed, and half the base (see F) is cut out with a chisel. This space, which is not deep enough to interfere with the four bonds, forms a feeding area into which the molten metal is poured.

The mould is now placed in an oven in the position shown in Fig. 16, and on heating the wax layer melts and runs away, leaving a space between the walls of the model and the mould, the central core being kept in its place by the four bonds which enter the mould on each of the four sides.

Fig. 17 shows the mould turned upside down in the position for pouring, the

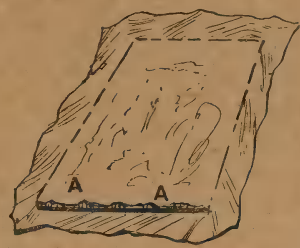


Fig. 18.—Taking a Papier-mâché Matrix

metal finding its way in along the space indicated by the black line round F, there being no necessity for rising channels, as the feeding area is so great, while the head of metal held in the cavity F ensures all parts of the casting being supplied.

Casting from Papier-mâché Matrix.—Papier-mâché makes a good matrix and is well adapted for taking casts from very fine and shallow engravings where the plate of metal is very thin. The process is as follows: The plate is slightly oiled all over its surface, and a sheet of soft tissue-paper is pasted smoothly to a

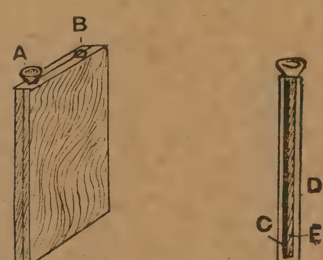


Fig. 19 **Fig. 20**

Figs. 19 and 20.—Frame for Making Cast from Papier-mâché Matrix

sheet of newspaper and laid on the face of the engraving. Over this a thin, damp cloth is spread, and with a brush made from stiff hairs all of one length like a stencil brush, the paper is worked into all the lines of the graving, care being taken

not to use the brush so forcibly as to tear the paper. Fig. 18 illustrates the general method, and in this figure the engraved face is shown in section at A. After the first sheet has been applied

Fig. 21.—Modelled Picture Frame

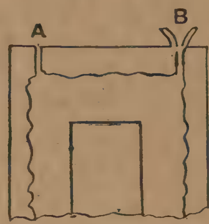


Fig. 22.—Picture-frame Mould with Pouring Gate and Riser

and well beaten in, other pasted layers follow, each being worked well in with the dabbing brush, while the last three or four layers should be of stouter paper, to impart strength and durability. Finally, weight is applied, and the paper left till dry, when the matrix should come away easily from the slate, carrying a clean, sharp copy of the impression. It is next trimmed to the size of the casting frame (Fig. 19), and the embossed portion is dusted over with finely powdered plumbago, which should be well worked into the details with a fine, soft brush.

The casting frame is shown in side section by Fig. 20, where D is the wall of the mould, C the matrix, and E the space for the fluid metal. As shown in Fig. 19, A is the gate for running in the metal, and B is a small circular opening, which allows the air to escape and serves the purpose of a riser.

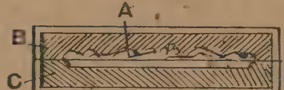


Fig. 23.—Picture Frame in Plaster

Casting a Frame in Plaster Mould.—Figs. 21 to 23 show a metal portrait-frame with details for casting it in a plaster-of-paris mould. The model, which may be worked out in clay, is well oiled and then immersed half its depth in liquid plaster held in the tray C (Fig. 23). After this has set, the surface of the plaster is cut level, well soaped or oiled, and the upper frame B placed in position and filled with plaster. A shows the model embedded in the mould, the lifting surface being indicated by the straight line which intersects the whole, and it only remains, after both sides are set, to cut the ingate B and the riser at A (Fig. 22).

In casting, the usual process of dusting the mould well with powdered plumbago should be followed, and the model may, instead of being shaped in clay, be a metal or carved-wood frame already in use, but in this case all parts which are undercut must be carefully filled up with clay or plasticine so as to lift easily.

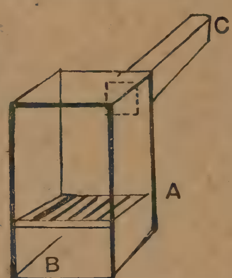


Fig. 24.—Box Furnace to Build into Flue

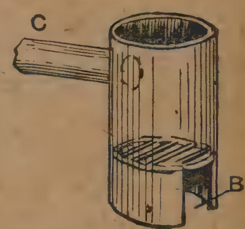


Fig. 25.—Furnace Made from 12-in. Cast Pipe

Zinc may be used instead of stereo metal, and although it has a reputation for pastiness, it fills the mould very sharply, and may be used for small castings. Large ones it is not adapted for, as it shrinks too much and tears itself in the process ; but if the heat is not raised too high to burn it, and the surface is dusted with a layer of charcoal, it will cast easily.

Furnaces for Brass Melting.—So far, the metals dealt with have been those which are readily melted on the ordinary fire, and it now remains to deal with those requiring temperatures which entail special furnaces, while the casting must also be done with another substance, namely, sand. Figs. 24 to 27 show four different types of furnace, the first two of which require building into a chimney

flue in order to obtain sufficient draught, and the last two are worked by a gas-jet and bellows. Fig. 24 shows a square into box without a top, made of $\frac{1}{16}$-in. boiler plate, and lined with small fireclay

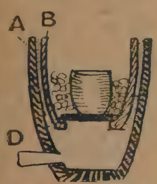


Fig. 26.—Two Crucibles Forming a Furnace for Blast

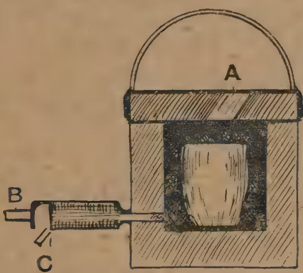


Fig. 27.—Fireclay Furnace for Blast

tiles set in fireclay. The chimney leading to the flue at the back must also be lined with this material, and the rectangular portion at B is cut away for the admission of air. A row of fire-bars is shown at A, resting at each end on a flange, and these bars support the coke and the crucible, while the top is covered during working with a fireclay slab. Fig. 25 shows another of the same style made from a 2-ft. length of 12-in. cast pipe, also with a space cut away as shown at B. Both these furnaces must be lined with firebricks cemented to the walls with fireclay; this last may be purchased dry and should be mixed with water to a stiff paste, which, after beating well, should be allowed to stand a few days to temper.

The furnace shown by Fig. 26 is constructed from two old plumbago crucibles of different sizes, A and B. The inner one has the bottom chipped out and its place taken by a small iron gully grate, while a circular hole is cut in the larger one at D to admit air from a pair of bellows.

In all these three furnaces the fuel used is coke. Common gas coke will answer, but as this always contains much sulphur, it is advisable to buy furnace coke, which is more expensive, but goes considerably farther. The coke should be the size of marbles, and after heating up with the blast, a hole should be made in the centre to accommodate the crucible, then drawing the fuel round the sides.

Fig. 27 is a cross section through a gas furnace that is made entirely of fireclay in the shape of a cheese-box, and which could be easily made at home from fireclay and some hooping. The top has a slanting hole A of about $1\frac{3}{4}$-in. diameter in the lid for the escape of burnt gases, and a semicircular iron handle is also fitted to the lid; B is the entry for the air blast, while C is that for the gas, the two being adjustable so as to obtain a proper mixture, which, when working effectively, should emerge a couple of inches out of the hole A.

Crucibles.—These are of either clay or plumbago of the shapes shown at A and B in Fig. 28, the tops of the clay ones being usually triangular to admit of easy pouring, while those of plumbago have commonly a lip. The clay ones are made of a mixture of fireclay with cement, burnt clay, etc., and have the drawback of absorbing moisture, which lays them open to the attacks of frost. Those termed plumbago

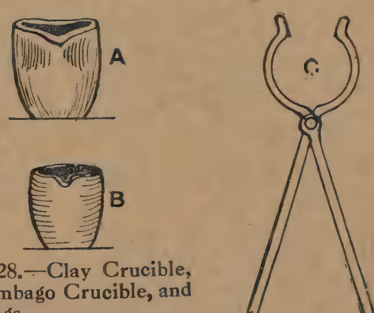


Fig. 28.—Clay Crucible, Plumbago Crucible, and Tongs

are made from fireclay mixed with powdered graphite, and their cost is roughly 1d. per pound, calculated on the weight of metal which they hold. All crucibles should be annealed before use, which is done by heating them in the furnace for an hour or so in an inverted position—that is, mouth downwards—and allowing them to cool very slowly. Of tongs for lifting them, the most useful shape is that shown at C (Fig. 28), where the ends of the tongs encircle the crucible; this method

of lifting is safer than taking hold of one portion of the side.

Moulding Sand and Flask.—For the moulds, sand forms the best material, as it is cheap, infusible, adhesive, and porous, while it retains any form given to it very sharply, and yet it is so open in its structure as to allow gases to escape freely. Sand containing lime or magnesia is too dense to be of any use, while for fine work a proportion of loam is mixed with the sand; but in this latter case the ramming must not be so tight as for sand alone, or the gases cannot escape. For work on a small scale the sand is best procured from a brassfounder; but it should be well sifted before use, and damped slightly before pressing into the boxes. New sand must be used for ramming against the side of the model, as the grains of this are sharper and cohere better than old or burnt sand; but old sand may be used for filling up the rest of the mould.

The moulding sand is held in a box known as a "flask," the usual shape of which is shown by Fig. 29. The flask consists of two strongly made wood frames, there being four pins B on brackets fitted to the lower frame, these pins corresponding with holes A in the brackets on the upper frame; these must fit accurately so that both halves of the mould are in perfect register, otherwise the casting will be distorted by one side of the mould not coinciding with the other. Two circular holes, half in each frame, will be seen at the end of the flask in Fig. 29. One of these forms the gate for pouring in the metal, while the other allows gases and steam to escape and forms a riser which, by overflowing, shows that the mould is full.

Moulding and Pouring in Brass Casting.—Fig. 30 is a section of a model and mould, the filling of which is done as follows: The bottom frame C is laid on a flat moulding board, and is filled up with damp sand rammed up tight throughout. A cavity is now cut out large enough to hold the model embedded to half its thickness, and a little fresh sand is sprinkled in this and the model rammed up tight. The surface of the sand is now flat and smooth as represented by the line D, and this surface is now well sprinkled with parting sand, which allows the top packing to leave it readily when lifted. The frame B is now placed on C by means of the pegs and holes in the four brackets, and after sprinkling a little fresh sand over the model A, the top frame is well rammed up with sand until level. It should now be as shown, the model A firmly embedded in the middle of well-packed sand, which, however, easily separates by reason of the parting sand when the top frame is lifted from the lower. The upper frame has now a moulding board placed on it, and gently rapped with a mallet to render the model easy to lift. The upper frame B is lifted off, the model lifted straight out so as not to disturb the sand, and the two cavities, representing the two halves of the model, dusted lightly, first with pea-meal, and then with finely powdered charcoal.

Channels are now cut from the cavity to the ingate and the riser, and after gently blowing away the surplus charcoal, the two frames are put together and the backboards bolted together, as shown in Fig. 31. The metal is now run in until it overflows through the riser, a good head of metal being kept in the feeding basin so as to ensure all the lines of the mould being properly filled. Charcoal is used for preventing the metal from burning the sand, and so forming rough castings. It acts by burning, and thus giving off gases which form a layer between metal and sand, while the pea-meal helps the charcoal to adhere to the mould's sides, which otherwise it would have little affinity for.

Parting sand for brass moulding is made from finely powdered firebrick dust, its nature preventing the two surfaces of sand in the upper and lower frames from cohering; for very fine work, loam is added to the sand, while the ramming is not so hard, so as to allow the gases to escape.

Various Models. — Fig. 32 shows a series of small models half embedded in

the lower half of the flask ; these have their cavities connected to a central channel, so that a large number of articles may be cast together, each being connected when cold by a thin metal bond to the runner. Figs. 33 to 35 show the model for a drawer handle, which

the final casting being made in brass or bronze. The gates or runners for brass must be larger than for iron ; but the head of molten metal for feeding need not be so big, nor is the riser channel so essential.

Making Brass.—The making and casting of brass require many precautions,

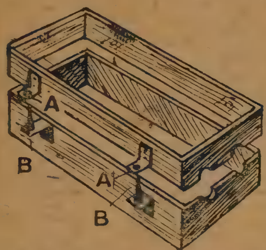


Fig. 29.—Flask, or Mould Box

Fig. 33

Fig. 34

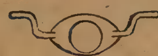


Fig. 35

Figs 33 to 35.—Drawer Handle

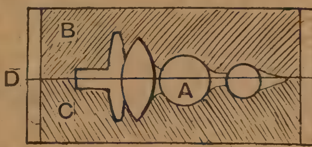


Fig. 30.—Section of Model and Mould for Brass Casting

Fig. 36.—Metal Figure for Cabinet

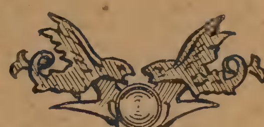


Fig. 37.—Metal Figure for Cabinet

Fig. 38.—Picture Frame to be Cast in Metal

Fig. 31.—Backboards Clamped to Mould

Fig. 32.—Models Half Embedded in Lower Part of Flask

may be cut out of thin, hard wood, and polished to lift easily. Fig. 34 is a section showing the bevel and the bosses A for the handle (Fig. 35). This handle may be either cut from sheet metal or cast separately, the bosses being drilled to receive the ends of the handle, which is sprung in. Figs. 36 and 37 show models suitable for the enrichment of small cabinets, etc., while Fig. 38 shows an idea for a picture frame in wood or plaster,

due to the liability of the zinc contained in the alloy to burn off ; and the custom is to melt the zinc in a crucible and add the copper in small portions at a time, until a nearly solid alloy is produced. This is broken up and re-melted with the proper proportions of zinc. A certain amount of old brass facilitates the mixture of the copper and zinc. The suitable proportions by weight are : 41 parts of old brass, 55 parts of copper, and 24

parts of zinc. The old brass is first introduced and melted down, then half the zinc in small pieces covered with a layer of coal dust, then half the copper with a layer of coal dust, followed by the remainder of the zinc and copper with coal dust in between and on the surface. The whole is now heated for about three to four hours, and, after skimming the surface, is ready for casting.

Making Pewter, Gunmetal, and Pinchbeck.—Pewter, which is an alloy of 4 parts of tin with 1 part of lead, melts much more easily than either of the two metals separately, and may be readily cast. Gunmetal consists of 90½ parts of copper to 9½ parts of tin. It is harder and more fusible than copper, and on account of the difference in the specific gravities it is difficult to mix: but the usual method is to melt the tin with twice its weight of copper, then re-melt with the proper amount of copper with constant stirrings. Pinchbeck consists of 3 parts of copper to 1 part of zinc, and Prince's metal of equal parts of the two.

Casting Aluminium. — Aluminium melts between the heat of antimony and silver, namely 1,200° F., and as it does not volatilise there is no danger of loss. It, however, absorbs gases when raised much higher than its melting point, and is liable to give spongy castings. Plumbago crucibles with lids should be used for this metal, and the sand should not be rammed very hard, while large ingates and risers are necessary. No flux is required, but when dirty scrap metal is used, a little saltpetre should be forced down to the bottom of the crucible.

Useful alloys of aluminium are: Copper 1 part, nickel 3 parts, and aluminium 96 parts; or for light machine parts, 82 parts of aluminium, 15 parts of zinc, and 3 parts of tin.

Bismuth and Cadmium Alloys.—Alloys of bismuth and cadmium are peculiar inasmuch as their melting points are far below their constituents, some melting readily in hot water, which makes them very suitable for taking impressions from wood or paper matrices. The following mixtures form readily fusible alloys: Lipowitz's alloy, melting at 150° F., consists of 8 parts of lead, 4 parts of tin, 3 parts of cadmium, and 15 parts of bismuth. Metallic cement consists of 8 parts lead, 3 parts of antimony, and 1 part of bismuth. Rose's metal, melting at 17·42° F., contains 8 parts of lead, 3 of tin, and 8 of bismuth. An easily melted alloy, suitable for casting from wood engravings, consists of 5 parts of lead, 3 parts of tin, and 8 parts of bismuth.

Acids for Etching Metals

THE fluids employed in etching designs on metallic surfaces vary considerably, but the following are typical:

For copper and brass: (*a*) Nitric acid 2½ fl. oz., water 5 fl. oz., mix. (*b*) Salammoniac, sea salt, and verdigris, each 4 oz., vinegar 8 fl. oz., and water 16 fl. oz.; boil for one or two minutes in a glazed vessel, cool, and decant the clear portion. (*c*) Water acidulated with sulphuric acid; for rapid or deep biting add more acid, and keep in a stoppered bottle.

For steel, take: (*a*) Iodine 1 oz., iron filings ½ dr., and water 4 fl. oz. (*b*) Iodine 3 dr., iodide of potassium 1 dr., proof spirit 1 fl. oz., and water 2 fl. oz. (*c*) Pyroligneous acid 4 fl. oz., and pure alcohol 1 fl. oz.; mix, and add 1 fl. oz. of nitric acid. (*d*) Hydrochloric acid 5 parts and water 95 parts; mix and add the liquid to a solution of chlorate of potassa. 1 part in 50 parts of water.

For gold, nitro-hydrochloric acid, diluted to the required strength, is used. Without dilution, this will dissolve gold.

For silver, use nitric acid diluted to the required strength—about 20 of acid to 80 of water.

Gold and silver are seldom etched, as the process is wasteful.

Making and Finishing Hand-sewn Boots

The advantage of making-up a boot in the hand-sewn style is that all peculiarities in measurement or shape can be coped with. The wooden last may be fitted in any way necessary to the requirements of the foot (see Figs. 1 to 3); its length may be increased by padding the heel and toe, or the width of its bottom may be added to by tacking "runners" along the last edge. In fitting up this last, it is only necessary to tack on a piece of leather in the exact position where the extra measurement is required, and to skive down and "bed" the leather to the last so as not to impede the pulling up of the upper.

Attaching and Preparing Insole.—Having fitted up the uppers as described in an earlier chapter, next prepare and attach the insole (see Fig. 5) Cut the insoles from a mellow tanned shoulder, in two oblong pieces big enough to well cover the bottom of the last. Tack the insole on the last in its rough shape, the grain side downwards next to the wood. It is important now to "block" the insole to the last. Pull the surplus leather at the toe well over. Hammer it to the front of the toe, and drive a rivet through the leather into the toe of the last. Hammer the surplus leather on the inside waist well up against the side of the last, and rivet to the last. Bed the surplus leather over the heel, and rivet to the back and sides of the last heel. Next drive a rivet through the insole on the *bottom* of the last at the toe, one at

Fig. 1.—Method of Increasing Instep Measure for Hand-sewn Work

each joint, two on each side of the waist, and two in the middle of the heel. Leave in this position until the wet insole is just drying off mellow. Then withdraw all the block rivets from the sides of the last, and the insole will be found to be nicely moulded to the shape of the last bottom. Round up the insole closely to the last. Mark off for the length of heel. Next, beginning at the heel-mark, mark round the waist and forepart, $\frac{1}{4}$ in. inwards, for the feather. Again mark round, in line with the first marking, but $\frac{3}{8}$ in. farther inwards, the space between the two markings being intended for the inseam. Now mark again $\frac{1}{4}$ in. still farther inwards (see Fig. 5). Holding the knife at a slant, skive down from the mark *first* made, to the edge of the insole all the way round. Next, holding the knife upright, start at the heel corner on the second marking, and cut straight down, judging the depth to about half the substance of the insole. Cut in this way all round the marking. Now hold the knife almost flat on the last marking line, starting at the heel corner, the knife pointing towards the marking line which has just been pierced. Cut all the way round in this slanting manner, judging the knife point to reach up to the marking line last cut. It will now be possible to remove the freed leather as the result of the last cutting, thus resulting in the

Fig. 2.—Method of Increasing Joint Measure for Hand-sewn Work

Fig. 3.—Leather tacked on to Provide for Enlarged Toe Joint

insole being prepared with feather edge and inseam.

Lasting the Upper.—Now last up the upper, much as described in the first volume, but instead of using tingles, $\frac{3}{4}$-in. iron rivets must be used and left standing up, and the rivets must be driven through the upper to catch the insole just at the beginning of the feather skiving. (After lasting the upper with rivets, long "whip stitches" may be put through the inseam and upper, and the rivets then withdrawn, as in Fig. 11.) Figs. 6 to 10 show the lasting of the upper. The upper having been lasted in this manner, the welt (Figs. 12 and 13) must next be placed in position.

Welts.—The welts may be obtained ready cut from the leather shop, but one edge of the flesh side will require to be skived down the whole length of the welt. Place

Fig. 4.—Last Markings, Indicating how Insole should be Treated

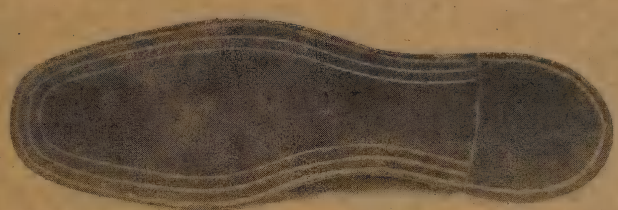


Fig. 5.—Insole Marked for Preparing Feather, etc.

Fig. 6.—Lasting the Upper

one end of the welt close to the lasting tacks at the heel corner, grain side next to the upper, and the skived edge nearest the lasting tacks or rivets. Drive

Fig. 7.—Cutting Leather at Toe

a rivet through the welt and lasting into the last. Pull welt forward to joint, keeping the skived edge close to the lasting tacks, and drive a rivet through the welt at the joint. Follow on to the toe, and drive a rivet at the side of the toe, one at the front, and one at the farther side. Follow on to joint and tack there, and finish at heel-corner. Do not cut away the spare length of welt, as some of this will be taken up in sewing.

Fig. 8.—Pulling up the "Joint"

Sewing in the Welts.—The welt is now ready for sewing in. Select an awl with medium-curved shoulder, and for ordinary substance men's boots use an eleven-cord thread for sewing in the welt. It must be noted that the welt has to carry the whole of the boot. Hold the boot on the knee with the toe nearest the workman. Start sewing at the left-hand heel corner. Place the point of the awl nearly flat on the insole with its extreme point next the inseam; that is, the square edge of the ridge formed by removing the freed leather in the last operation of preparing the insole. Force the awl through the inseam, upper and welt, bringing the awl-point out on the welt in a position

that is level with the feather edge of the insole. Insert the bristle of the thread from the inseam side, and pull half the length of thread through on the welt side. Now bore as before $\frac{1}{4}$ in. farther on, insert the bristle on the welt side, follow with the bristle on the inseam side, and pull up the threads evenly and tightly. Proceed in this manner until the toe is reached. In going round the toe it will be necessary to tap down the welt gently after each stitch. Again, care must be taken in boring on the inseam side, for whilst the holes on the welt side will be $\frac{1}{4}$ in. apart, they will be much closer on the inseam side until the toe is passed. Caution is needed, therefore, on the inseam at the toe, or the holes may break into each other. Proceed to the right-hand heel corner and cut off the surplus welt.

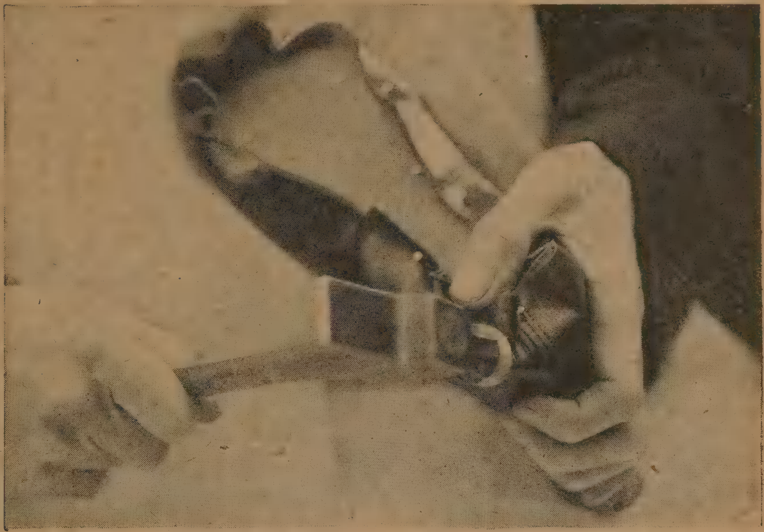


Fig. 9.—Laying Heel Pleats with Hammer

Fig. 10.—Upper Lasted for Hand-sewn Work

Fig. 11.—Whip Stitches

Sewing in the Heel.—This is the next operation. The awl is used on the insole in the same way as in sewing in the welt, but no inseam is usually cut for the heel. The awl is held at a smart angle, the insole well pierced, then whilst boring forward the awl is dropped nearly level. The stitch is brought out on the *upper* itself at the heel, as the welt does not extend beyond the heel corners. Use a thirteen-cord thread for the heel, as the stitches will have to carry the heel itself. Do not pull up the stitches too tightly, and see that the line of sewing is uniform, and is in line with the beginning of the heel feather—that is, $\frac{1}{4}$ in. from the edge of the heel insole. (Sometimes a last having an iron-plated heel section is used, in which case the heel of the upper is lasted down with tingles, as in Fig. 14, and the lifts then riveted on and not sewn on.)

Beating-up the Welt.—Having sewn in the heel, withdraw all lasting rivets and tacking rivets from the last bottom, and beat up the welt. The welt may possibly have got dry by this time, and it will be desirable to damp it by means of a sponge. Insert the bone, or a wedge-shaped boxwood stick, between the upper and the welt, and ease it upwards. Then, using the beater, bring up the welt level with the lasting (see Figs. 15 and 16). Careful manipulation will be needed at the toe. When the welt is beaten up at the toe, hold the beater flat under the welt and gently tap the welt itself to level. After beating-up, trim away the surplus upper material between the welt and inseam, and tap smartly down. Do not forget to insert a felt filler (see Figs. 17 and 18), which acts as a pad between insole and outer sole, and prevents creak-

Figs. 12 and 13.—Placing in Position the Welt for a Hand-sewn Boot

ing of the boots in wear. Cut the shank-piece (Fig. 19) rather wider for this boot than as described for riveted work, and fasten to the insole by means of two

Fig. 14.—Heel Lasted Down on Iron-plated Heel Section

whip stitches at each end. The boot is now ready for the outer sole.

The Outer Sole.—Cut out the outer sole (Fig. 20), soak well, and leave till mellow. The draught or stretch must be removed before sewing, as follows: attach the outer sole by driving a long rivet at the toe, next pulling the sole tightly towards the waist (see Fig. 21) and driving a long rivet at each joint. Drive a long rivet at the heel. Next round up the sole roughly, and block the waist by bedding down (Fig. 22), and driving three long rivets on each side of the waist. Leave to set in this position. When set, withdraw the waist rivets, round the waist up closely, finish rounding by trimming forepart and welt to the desired shape, and leave the heel rounding a little full.

Fig. 15.—Welt Sewn in and Beaten Up

Bevel the inside waist, before cutting the channel, by using the rasp, and then scrape and glasspaper the bevelled waist. Next cut the channel from heel corner to

Fig. 16.—Welt Standing Clear of Upper

heel corner, having previously marked off for length of heel, and sew on the sole (see Fig. 23). Use a nine-cord thread for this operation, and sew about ten stitches to the inch. With a prick-stitch, a tool resembling a small screwdriver, mark the welt between the stitches (see Fig. 24), so as to remove the effect of bareness, and to make the stitches more prominent. Withdraw the tacking-on rivets, paste and lay the channel, and proceed to attach the heel.

Attaching the Heel.—In a sewn seat

the whole of the heel is sewn on through the stitches on the upper, excepting, of course, the top-piece. Cut out and mould the split lift (see Fig. 25), and attach it to the seat of the outer sole by boring with the pegging awl. Drive a few pegs round the seat through the split lift and the heel of the outer sole. Next place the lifts in position, and drive a few 1 in. or $1\frac{1}{4}$-in. rivets from the top lift through to the heel of the last. This will keep the heel firm while rounding and sewing. Next round up and shape the heel as correctly as possible, and proceed to sew in. Place the awl point under the stitch on the upper, and bring out the awl on the top lift. Insert the bristle from seat side under the upper stitch, and draw half the length of thread through on the top lift side. Now place the awl point under the next stitch on the upper and bore through top lift as before. Insert the bristle from lift side and bring it out under the stitch on the upper. At the same time in-

Fig. 17.—Bottom Filler

Fig. 18.—Placing the Bottom Filler

Fig. 19.—Placing the Shank

sert the right-hand bristle under the upper stitch, bringing it out on the top lift, and pull up the threads firmly.

Fig. 20.—The Outer Sole

Proceed in this way until all the heel stitches have been sewn in. Cut the threads, hammer down the top lift, and hammer the edge of the heel portion of

Fig. 21.—Removing Draught or Stretch from Outer Sole

Fig. 22.—Blocking the Outer Sole : "Bedding the Waist"

the outer sole to close up the seat. Attach the top-piece in the usual way with rivets, and the boot is ready for finishing (see Fig. 26).

Riveted Seat for Heel. — Another way of treating the heel in hand-sewn work is to make a riveted seat, the heel of the last being plated with iron (see Fig. 14). At the time of lasting in the upper, the seat is lasted down with tingles exactly as described in making a riveted boot. After the sole is sewn on, the seat of the outer sole is riveted down. The last is then withdrawn, and the heel completed on an iron last.

Height of Heel.—The height of the heel must be according to requirements ; but for a hand-sewn walking boot it is usually 1 in. from the seat to the top-piece. This measurement includes the

heel portion of outer sole, the split lift, the lifts, and the top-piece. This heel will be built square—that is to say, in rounding the heel of outer sole and the split lift, the rounding will only be very slightly inwards. A rule placed on the top-piece of the heel and resting on the joint of the sole should be level (compare Fig. 27 with Fig. 28).

Width of Welt.—The width of the

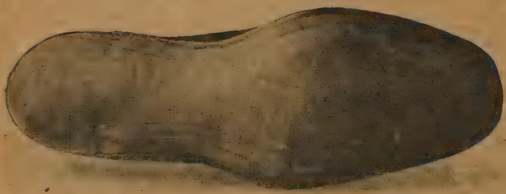


Fig. 23.—Outer Sole Sewn on

welt will be a matter of taste, and by trimming up after the welt is sewn in, the boot may be left a full wide, half-wide, or close welt, as desired. Fullness of welt, in any case, should be left either at the outside or inside joint as will be most suitable to the tread of the wearer.

Fig. 24.—Pricking Up the Stitches

THE "COMBINATION" BOOT

A style of boot that requires an iron last is the "combination" boot. This style is made by lasting the upper exactly as for a riveted boot, and riveting on a "middle" sole from heel to toe. The outer sole is then *sewn* on by hand, the edge of the middle sole acting as a welt for the sewing. The boot is therefore partly riveted and partly hand-sewn—hence the term "combination."

The method of making a "combination" boot is exactly as described in making the riveted boot (see first volume) up to the time when it becomes necessary to attach the middle sole. At this point the cutting out of the middle sole will depend upon whether a double outside and inside waist is required, or whether double outside only. Assuming that the double waist on each side is required, the middle sole, instead of being carried only to the joints, will be carried right through to the back of the heel just as the outer sole (see Fig. 23).

The middle sole for this boot will require to be cut from mellow material, as the edge of the middle will, of course, have to act as a welt. Attach, round-up, and follow the description given in so doing as applies to the outer sole in making the riveted boot. Fasten down with short iron rivets. Cut out the outer sole, tack on and round-up to the middle sole. Mark off for the heel, and mark across the joints. Withdraw the tacking-on rivets, and remove the sole. Thin down the sole, on the flesh side, between the heel and joint markings. Hammer the sole, lay a piece of felt on middle sole, and again attach sole by driving a long rivet at toe, two at each side of the waist and one at the heel. Run the rasp around the sole edge, and next remove the "burr" on the sole

edge caused by rasping. Start at the heel corner and mark round $\frac{1}{8}$ in. inwards, finishing the marking at opposite the heel corner. Hold the knife upright, with its point on the commencement of marking at the heel corner. Grasp the knife with the fingers, press the thumb against the sole edge, and, penetrating the leather about half-way through its substance, cut a channel in the outer sole on the mark previously made. Insert the corner of the lifting awl at the heel corner of the channel, and drag it round the sole, turning back the "lip" of the channel.

Fig. 25.—Fixing the Split Lift

Fig. 26.—The Heel Built Up

Proceed to sew on the sole, using a stout thread for the purpose. Close down the channel, and rivet down the seat of the outer sole. Afterwards, attach the split lift and proceed as described in making a riveted boot.

To make a combination boot with a single inside waist and double outside, the middle is attached as described for making a riveted boot; that is to say, the middle sole does not extend beyond the joints. Having attached the middle with short iron rivets, cut a strip like a split lift (Fig. 29). Continue the middle on the outside joint by means of this strip by riveting the strip down, beginning at the joint and carrying the strip to the heel corner. Round up the strip uniform with the middle sole. Attach the sole and cut the channel as previously described. The inside waist will be fastened down by what is known as "channel riveting." Drive the rivet in the channel as far as possible. Then place a steel punch on the rivet head, and drive the rivet well down. Proceed in this way until the inside waist is firmly secured, then sew down the rest of the sole by hand, and continue the making, as described.

It should be noted that the middle soles for the combination boot should be

riveted down by means of short iron rivets, as the middle has to bear the whole strain of the bottoming.

MACHINE-SEWN BOOTS

In preparing for the machine-sewn boot, proceed exactly as in making a riveted boot up to the point of attaching the middle sole, as already explained. Then, instead of tingling the middle sole down firmly, simply tack on with a few tingles about 1 in. inwards from the lasting. Attach and round the outer sole, and cut a channel for the sewing. The channel is cut rather differently from when cutting for hand-sewn. Beginning at the heel corner, hold the knife at such an angle that the bottom of the channel will be in line with the edge of the insole $\frac{1}{4}$ in. inwards. The machine will have to sew through the channel and the middle sole, and lay the stitches on the insole inside the boot. For this reason, the angle at which the knife is held when cutting the channel will depend upon the middle width extending beyond the lasting. Open the channel wide, as the stitch it will have to carry will be a chain-stitch, consequently a double thread. Most grindery and leather shops have a "sole-sewing machine" in use, and will put in the stitches for a few pence. After the soles are sewn on, lay the channel lip back in position, and proceed to heel and complete the boot as in riveted work.

Fig. 27.—Testing Heel Pitch: Heel too High

"TACKLESS" BOOTS

Another style made by the aid of sole sewing is the "tackless." Cut a light inseam on the insole as if for hand-sewn, and last the upper as for hand-sewn, but without a welt. Now sew through the inseam and upper, but instead of using two ends as in hand-sewn, use a single thread. Tie a knot at the end, start at the heel corner, passing the bristle through from the inseam side and out on the upper. Now overcast the thread, bringing the bristle back to the inseam side, and sew through as before. Continue in this way

Fig. 28.—Testing Heel Pitch: Heel at Correct Height

round to the other heel corner. Remove the lasting rivets, fill up the bottom, attach middle and outer sole, and channel as described for machine-sewn. The sole sewing will, of course, bind the outer sole middle and upper to the insole, the boot thus being made without tingles in the lasting. Rivet down the heel, build it up, and complete as in making a riveted boot, as explained earlier in these volumes.

THE FAIRSTITCHED BOOT

This is made exactly as described for the combination boot, the difference being that the outer sole stitches are put in by a machine instead of being sewn in by hand. Most leather shops will do this work for a few pence, after which proceed as described for the combination boot. The fairstitched boot in this case will have a double waist, but if a single inside waist is desired, the middle sole may be prepared as described in making the combination boot. The operator at the machine will put in the fairstitching round the forepart and outside waist, and on instruction from the maker, the inside waist may be sewn down by the sole-sewing machine. The real advantage to the man making a pair of boots by hand, and utilising the services of the sole sewer, lies in the fact that he may make an extremely light boot by lasting up as for riveted, and then dispensing with the middle sole. The outer sole is then attached, channelled, and sewn on by the sole sewer, making what is termed a single-soled boot. By this method the hand-maker may turn out a boot that is both very light and flexible, whilst the boot is practically hand-made.

MAKING A WAXED THREAD

No matter what amount of care may be taken in preparing a boot and a sole, if an imperfectly made sewing thread is used the repair will not stand in wear. The "number" of hemp, the class of wax, the number of strands, the method of applying the wax, and the twisting of the strands are all matters of importance in making a waxed sewing thread that can be depended on.

For ordinary use in sewing on soles by hand, No. 15 hemp should be purchased. Wax of a copper colour should be selected, being more reliable than the black variety, and a pennyworth at a time will be enough. The balls of wax not in actual use should be kept in water. The next purchase is a few bristles for attaching to the ends of the sewing thread. These should be of the light-coloured variety, fairly firm. This comprises the full outfit for making the threads.

Place the ball of hemp in a tin, bringing the end through a hole in the lid. This will prevent leather dust and dirt from attaching to the hemp. Place the hemp

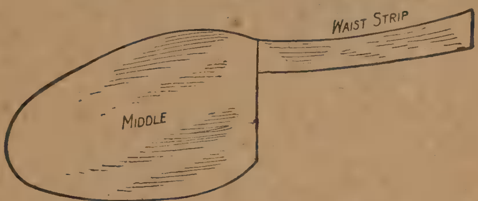


Fig. 29.—Middle and Waist Strip for "Combination" Boot

tin on the floor to the right hand, draw up the thread on to the right knee, and break off a few inches of thread to get a taper. It is necessary when breaking the thread to draw it apart in such a way that each broken end has a tapering point, all the ends in turn when the thread is twisted forming a long fine taper to receive the bristle. Clean breaking of the thread or cutting will not be of any use, as in that case no tapering end could be obtained.

To break the thread properly proceed as follows: Lay the thread on the right knee, holding the end with the left hand. Place the palm of the right hand on the thread on the knee, press firmly down, and roll the thread away. Then roll it half way back again in the same way, press tightly down with the right hand, and bring the left hand forward, holding the thread between finger and thumb to within an inch of the right hand. Now give a short "snappy" pull with the left hand, and the thread will separate with a fluff to each broken end (see Fig. 30). Throw away the part in the left hand if

beginning a new ball, as the end of that piece of hemp not broken will have an ordinary straight cut, and if this strand is used it will spoil the making of the thread.

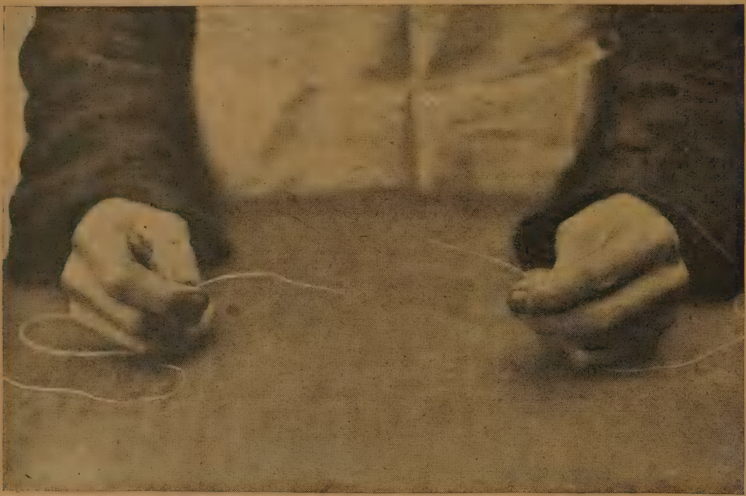


Fig. 30.—Tapered Ends of Hemp Caused by Breaking

Now with the left hand draw a length of about 5 ft., and break the thread as described. Place the end of the broken thread against the wall end, but let the ball end be a shade longer than the end of the broken thread. Hold the two ends in the left hand, allowing the thread to lie loosely under the palm of the right hand, with the fingers bent under to keep the threads together, and draw out the second length, using the first length, of course, as a guide to measurement. Hold back the first thread with the last three fingers of the left hand, and with the thumb and forefinger again break the thread as before. It is necessary to hold the previous detached thread or threads out of the way whilst breaking off another strand, or they will become twisted and cause complications. Proceed in this manner until a sufficient number of strands have been obtained, being very careful to break all the threads of slightly different lengths to obtain the tapered end (see Fig. 31).

Fig. 31.—Getting the Strands of Uneven Length

Next hold the threads in the middle of the left hand, moisten the right hand, and stroke down each half-length of threads (collectively, of course; not the single strands), and this will remove the loose "fluff" from the hemp, which helps to make a smooth-working thread. Now take the wax, and,

if it seems at all brittle, "work it" between the palms of the hands to make it more pliable. Rub down the thread a few times with the wax (see Fig. 32), and everything is ready for twisting the thread. Perform this operation in the following manner: Lay one end of the thread over the right knee, allowing the tapered end to be well out of the way to the right. Take hold of the thread midway with the left hand, gripping the thread tightly. With the right-hand palm over the thread on the knee, roll the

Fig. 32.—Waxing the Thread

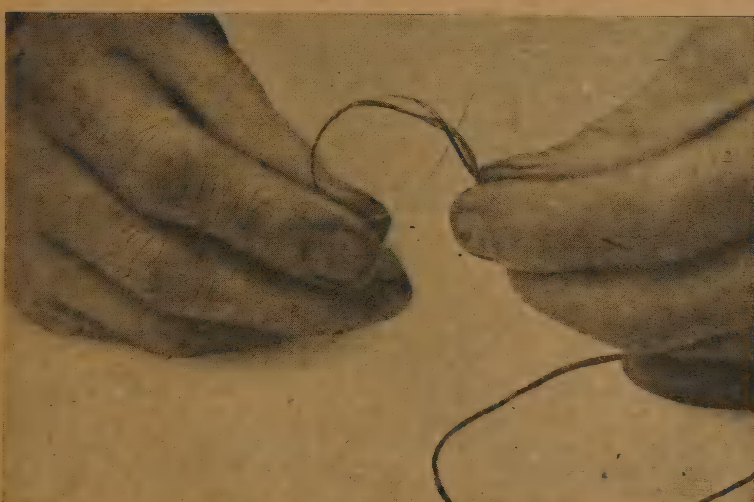


Fig. 33.—Attaching Bristle to Waxed Thread: "Locking"

thread away, bring the thread back to its first position on the knee without rolling, and again roll away. Repeat this operation several times, and the thread will begin to be twisted. When the thread begins to "curl" up there is sufficient twist. Take hold near the taper end, and pull the thread firmly to take out the "curl." Now treat the other half of the thread in exactly the same way, and complete the waxing of the thread by giving it a few more rubs. Do not place too much wax on the thread, but see that no white strands are showing through the wax.

Now twist the tapered ends. Do this very gently, and apply the wax carefully, or the fine ends will snap, and if this should happen the thread would be rendered useless.

Attaching Bristles.—The bristles can now be attached. One end of the bristle has a split-hair appearance, and this is

the end which has to be attached to the thread. At the other end of the bristle it will be noticed that about $\frac{1}{4}$ in. of its length is of a more dead white colour than the remainder. Cut off this portion, as it is softer than the other part of the bristle, and would split in use. Carefully wax the split part of the bristle to half the bristle's length. Next give the thread a few rubs with a piece of patching leather to spread the wax more evenly, and proceed to attach the bristle.

There are several ways of "bristling," as it is termed, but the following, known as "rolling," is the strongest: Hold the bristle in the left hand, split end downwards; take the taper end of the thread in the right hand, and place against the bristle, with the end of the taper pointing upwards. Let the extreme end of the thread be in a position nearly half-way of the bristle length. Now twist the end of the thread taper once or twice round the bristle, twisting upwards towards the bristle point. Next turn the bristle round, bringing the point downwards, and continue twisting towards the split end of the bristle to within $\frac{1}{2}$ in. of its extremity. Exactly at this point of the thread make a hole through the thread with a fine awl, insert the using end of the bristle in this hole, and draw the bristle right through (see Fig. 33). This is termed "locking," and is to prevent the bristle from becoming untwisted and working off the thread. The thread is now ready for use. The number of strands required in making threads for different classes of work will be found stated in other chapters.

Fig. 34.—Using the Heel Shave: The Start

FINISHING NEW BOOTS

Finishing new work differs in many respects from the finishing of repairs (described fully in a later chapter). The tools used could not be applied to repairs, because in the new boot all the material is new and mellow, and there are no obstructions in the way by old nails or rivets. Again, a better style of edge-finishing is expected, and double guard forepart irons are used for setting the edges.

Finishers' Tools.—The tools required to turn out a good job will be a heel shave, a drag knife, a double guard forepart iron, a waist iron, a fudge or stitch wheel, a crow or fancy wheel, a seat wheel and a plough, in addition to the usual rasp and scraper.

The heel shave is a tool resembling a carpenter's spokeshave with an iron frame. It is made in about six different curves of blades, ranging from the blade to suit the square, flat heel to the extremely hollowed Louis heel in ladies' goods. The method of using is as follows. Hold the boot on the knees with the heel farthest away from the worker. Lay the blade at the heel corner across the heel from top-piece to seat, and push the shave as far round towards the back of the heel as possible at the one stroke (see Fig. 34). Next place the boot between the knees, toe downward, and go round the back of

the heel at one stroke (see Fig. 35). Now place the boot with the heel nearest the workman, and go from where left off to the farther heel corner at one stroke (see Fig. 36). The blade of the shave must be set so as to give as fine a skiving as possible, otherwise the heel will be jagged in using the shave.

The drag knife should have a blade whose width is a shade more than the substance of the edge of the forepart of the boot. This is a tool with a concave blade and a single handle, and is used in the following way: Hold the boot, joint upwards on the knee, with the upper next to the workman. Hold the drag handle in the right hand, and lay its blade at the joint of the forepart, in almost a flat position (see Fig. 37). Press the fingers of the left hand against the sole bottom, and rest the left thumb on the back edge of the drag. Now pull forward with the right hand, push with the left thumb, and guide the passage of the drag by the fingers of the left hand being held tightly against the sole bottom (see Fig. 38) With practice it is possible to go round from joint to joint at one cut without removing the drag from the edge.

Fig. 35.—Using the Heel Shave : Back of Heel

The plough, or "bit knife" as it is usually termed, is intended to take out a fine strip of leather between the upper and the edge of the welt, and also to take out the jagged edge of the seat next to the upper at the heel. Figs. 39 and 40 show it in use.

Fig. 36.—Using the Heel Shave : Completing the Heel

The double guard forepart iron has two projections, or guards, on the face of the iron. One of these guards clips the welt edge and the other guard clips the under edge of the sole. The iron selected must fit the edge so that the guards act in compressing the edge of the sole and the welt together. The waist iron has rather deeper guards than the forepart, and is made of a shape

Fig. 37.—Using the Drag Knife: The Start

Fig. 38.—Using the Drag Knife round the Toe

Fig. 39.—Using the Welt Plough

to suit a round or bevelled waist, or a square waist.

The seat wheel is like a single guard forepart iron, but it has a small movable wheel let in the face of the iron. The guard of the iron is placed in the heel seat, between the upper and edge of heel part of outer sole. It is run round the seat of the heel in this way (see Fig. 41), and sets the edge of the seat whilst at the same time making a fancy marking on the seat edge.

Fig. 40.—Using Welt Plough: Removing "Bit" from Heel Seat

Fig. 41.—Using Seat Wheel

The fudge wheel is a tool with a toothed wheel at the end, and this is run round on the welt, leaving an impression of the "teeth" of the wheel (see Fig. 42). This tool may be had with close or open markings as desired. The crow or fancy wheel is used for marking across the waist line in new work, and makes a fancy impression, usually the herring-bone pattern.

The Process of Finishing.—First of all the inside of the boot must be examined, and any upstanding nails or roughness of insole must be removed before the boot is finished. Next, damp the heel, the breast of the heel, the waist and forepart edge, with a sponge. Now take the wedge-shaped end of the hammer, and "pane" up

the heel so as to properly close the edges of the lift to each other. Next trim

Fig. 42.—Using the Fudge Wheel

away the rough material of the heel, and shape the breast (see Figs. 43 and 44). Next trim up the waist on both sides, using a small, sharp knife for the purpose. Then drag up the forepart in the manner described for using the drag. Shave up the heel, taking care to keep the blade well away from the upper. Rasp up the forepart and the waist, using the fine flat side of the rasp. Now take the wide end of the scraper and scrape the breast of the heel well. Take off the " burr " or " nap " from the sole edge, and scrape the forepart and the waist edges. Run the edge of the scraper round the sole edge in the same way as if taking off the burr. Take the jagged edge of the leather out of the waist by the aid of the plough. Remove the " bit " from the seat between the upper and heel part of the outer sole (see Fig. 40). File and scrape the bottom and the top-piece. Run the smooth side of the rasp round the welt and inside the waist. File round the seat where the " bit " has been removed.

Next, glasspaper all parts, and damp the forepart. Try whether the iron fits, laying most pressure on the guard on the welt. The other guard will make an impression on the sole edge at any point where there is too much substance. Reduce the substance at places so marked until the iron fits, by rasping the extreme sole edge; afterwards scrape away the rasp marks and glasspaper the part. Fit the waist iron in the waist at both sides in the same manner. Next, damp the heel close to the seat.

Fig. 43.—Breasting the Heel

Slightly warm the seat wheel, and holding the boot with the top-piece farthest away from the worker, insert the guard of the seat wheel at right-hand heel corner. Put on as much pressure as possible, and wheel round to the opposite heel corner. Next, give the forepart a coat of ink, and while this is wet, run the forepart iron round the edge. Allow to dry, then mark off the waist, making a line across from joint to joint on the bottom of the sole, and ink the heel, breast, waist, waist edges, and forepart edge. To get the best result, the ink must be caught just when it is "drying off." Warm the forepart iron, insert at joint, holding the boot across the knees with the sole bottom farthest away from the workman. Put on heavy pressure, and move the iron forward with a sliding movement, not backward and forward. Go round the toe at one sweep. Turn the boot over on its other side and proceed down to the joint. During this operation, heaviest pressure will have been put on the guard at the welt side. Repeat the operation, placing most pressure on the sole edge side. If good burnishing ink is used, the result should be a bright edge. Treat the waist edges in the same way, and proceed to iron the heel and waist.

Fig. 44.—Trimming Breast of Heel

Fig. 45.—Heel Burnishing

By this time the ink will be dry on the heel and waist. Set the double-handled burnishing iron to warm. Dip the finger in the burnishing ink, and rub the wet finger over the heel and waist. Lay the boot across the knees, toe to the left, bottom away from the worker, or adopt the position shown in Fig. 45. Lay the burnishing iron flat on the heel, and work up and down from seat to top-piece, travelling towards the back of the heel. At this point, hold the boot between the knees, toe downwards, so as to burnish the back of the heel easily (see Fig. 46). Now lay the boot across the knees, heel to the left, and work to the heel corner.

Fig. 46.—Burnishing Back of Heel

Next, place the boot, bottom upward, on the knees, heel next the workman, and lay the burnishing iron across the waist as close as possible to the breast of the heel. Make a movement with the iron from this position to the waist-mark at one stroke (see Fig. 47). Warm the single-handled burnishing iron, and iron the breast of the heel and that part of the waist near the heel breast not reached by the double-handled burnishing iron. Heat the irons again, and give a second ironing in the manner described. The last coat in ironing new work is one of fake," not of "heelball," as in repairs. To make this, place a black and

Fig. 47.—Burnishing the Waist

a white heelball in an old polish tin, and nearly cover with naphtha. Leave in a warm place until the heelball has become pasty. Smear a little of the paste over all parts that have been ironed, and re-iron as before. Next warm the seat wheel so that the wheel revolves freely. Insert in position, and see that the wheel is on the marking previously made. Wheel round from corner to corner. Next heat the fudge wheel. Hold the boot bottom downwards, toe to the left. Insert at joint. Lay the wheel flat on the welt and proceed round the boot. Press firmly while going round the toe, or a double marking will result. The waist edges are not fudge-wheeled, except in case of double waist. All that now remains is making the bottom, fancy wheeling, and rubbing off.

A brown bottom for repairs is described elsewhere in this series of volumes, but a rather better class bottom is required in new work. The style adopted is usually a white forepart. This is made by a bottom wash, prepared in the following manner: crush into powder two white or pink bottom balls, which may be obtained at the leather stores. Put this powder into a pint bottle. Add twopennyworth of Epsom salts, fill up with hot water, and allow to stand overnight. Shake well before using. Pour a little on a piece of clean flannel, and rub quickly over the boot bottom, which should have previously been well glasspapered. Allow to dry, when it will come up white. If any of the wash has gone on the edges or on the black waist, a damp cloth will remove it. Next, rub a little white heelball on the extreme edge of the sole

Fig. 48.—Crow-wheeling the Waist Line

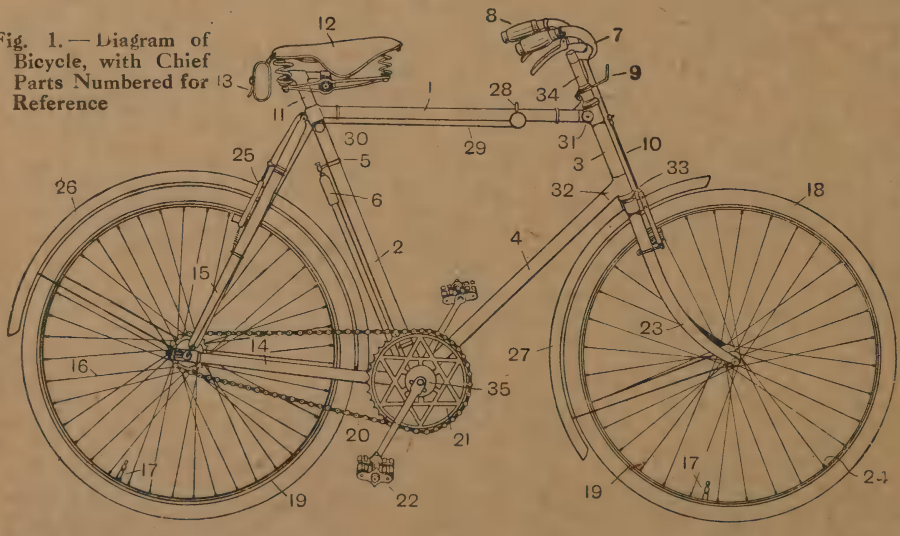
bottom, and run the warm iron around. This is termed "top-ironing," and will result in a brown strip round the sole edge. Pass the warm "crow," or fancy wheel, over the waist line (see Fig. 48), and "rub off" with a piece of soft cloth. Remove the last, tap the back of the boot by laying the inside of the back on the toe of the last, to lay stiffener flat between the lining and the upper. If the toe has fallen in pulling out the last, insert the long stick and raise the toe-puff. Place the tree in the last, and leave to set, and the making is completed.

Overhauling a Bicycle

THE reader is assumed to have purchased a secondhand bicycle, or to be about to start a bicycle tour, and to be desirous of thoroughly overhauling his machine to assure himself that it is in a reliable condition for severe use. In the first place, the following description will be all the more easily understood if the reader is made familiar with the names of the various parts of a bicycle. The illustration herewith (see Fig. 1) is a diagram of a modern bicycle, and the reference numbers to the various parts may be explained as follow :

1, Top tube ; 2, seat tube ; 3, head ; 4, bottom tube ; 5, top pump clip ; 6, pump ; 7, handle-bar ; 8, handle grips ; 9, lamp bracket ; 10, front rim brake forket ; 11, seat pillar ; 12, saddle ; 13, tool bag ; 14, chain stays ; 15, back forks ; 16, spokes ; 17, valve ; 18, tyres ; 19, wheel rim ; 20, chain ; 21, chain wheel ; 22, pedal ; 23, fork blades ; 24, nipples ; 25, back brake forket ; 26, back mudguard ; 27, front mud-guard ; 28, gear-change control lever ; 29, cable ; 30, pulley ; 31, head lock ; 32, joint of tube and lug ; 33, fork

Fig. 1.—Diagram of Bicycle, with Chief Parts Numbered for Reference



crown; 34, steering tube; 35, bottom bracket (behind the chain wheel).

The Frame.—A thorough examination of the frame should be made, especially at the joints where tubes are brazed into the lugs, for broken joints, cracked tubes, etc. The fork crown is a very vital part, and to examine this it should be removed from the head of the machine and examined at the point where the steering tube enters. Possibly the frame is out of truth, so that the wheels do not "track" properly owing to some fall or smash. To test the frame for "tracking," set both the wheels carefully in the centre of the forks, turn the machine upside down, and lay a long straightedge on the side of the back-wheel rim. It should then just touch the side of the front-wheel rim, providing both rims are the same width. Try this on both sides and at various positions of the wheels. Should this be much out of truth, the frame should be set true. This can generally be done cold by passing a long bar or stiff tube down the steering tube, with the handle-bar removed, and another bar inserted in the main down tube, with the seat pillar removed, using these as levers to pull the frame true.

Bearings.—All bearings should be thoroughly cleaned and examined for broken or defective balls, cones, or ball races, and renewed where necessary. It is a good plan to alter the position of the bottom-bracket discs by turning the fixed or chain-wheel side half a revolution in the bracket. This will bring a fresh portion of the disc into position to receive the greatest amount of wear. This also applies to wheel spindles and the bottom-head cone or race of the fork crown. The position of the pedal spindles might also be moved in the crank ends by fitting a very thin washer behind the pedal pin shoulder.

The bearings should be thoroughly cleaned out with paraffin and properly adjusted, so that they run free, but without shake. The best way to do this is to tighten them home, and then slack the cone back for a quarter or a half revolution. Then oil with good lubricating oil; best sperm oil is as good as any See that all lock nuts are securely tightened up.

Cranks.—Examine the cranks to see that they are true on the bracket axle, and that the pedal spindles are square with the crank face. The crank cotters may require tightening, and in doing this see that the cranks are not drawn out of line, and that the cotters do not project too far through the crank boss and thus cause the nut to bind on the shoulder at the base of the thread.

Mudguards and Brakes. — Mudguards and brakes should be examined for loose and worn parts, and adjusted and renewed where required. Probably new brake blocks, obtainable for a penny or two, may with advantage be fitted.

Wheels.—The wheels may now be taken in hand. Remove the tyres from the rims, spin the wheels and see that they run true, and that the spokes are tight, and that their ends do not project through the nipples. If they do, file them off flush, as this is a frequent cause of tyre troubles. If the insides of the rims are rusty, clean them well with emery-cloth, and give a coat of enamel, as rusty rims play havoc with tyres.

Truing an Old Wheel.—A wheel may be made out of truth by the breaking of a spoke, one or more spokes getting loose, or as the result of an accident. If it is out of truth slightly sidewise, it may be corrected without removing the tyre; but if it is much out, and especially in the round, then it is advisable to remove the tyre. Also, there is the risk of the spokes protruding through the nipples far enough to cause trouble to the air tube. If the wheel is true in the round, but out otherwise, spin the wheel whilst held in the forks of the machine, and, by holding a piece of chalk to the side of the rim, the part that is most out of truth will be marked. Feel the tension of the spokes on this side (where chalked), and if very tight, slightly slack the nipples at this place, and then tighten up those on the opposite side to the chalk mark. Care must be observed not

to overdo it at first; about half a turn should be tried, and then the wheel spun and chalked again. Should the nipples be a very tight fit on the spokes, it will be advisable to hold the spoke as close up to the nipple as possible whilst the nipple is turned with the nipple key. Otherwise the spoke may be twisted off or partly twisted instead of the nipple moving on the thread.

If there is unequal tension on the spokes the wheel will not remain true long.

Should a wheel be out of truth in the round, fasten a piece of wire across the forks just above the rim, as close to it as possible. Then turn the wheel slowly, and observe the low places; these should be chalk-marked, and the spokes let out on both sides at these places. Then find the high places, and tighten up the spokes on both sides at these parts. The exact amount to slacken out and take up in the spokes can only be found out by experience, and will be governed by the tension already on the spokes and the amount the wheel is out of truth; but it is best to be on the safe side, and underdo it rather than overdo it, as a wheel can soon be pulled out of shape and be spoilt by unskilful handling. All the time the truing in the round is going on, a sharp eye must be kept on the condition of the wheel sidewise, and this kept within limits. Frequent trials by spinning the wheel should be made, and want of truth corrected. When the wheel is true in both directions, and all spokes brought to an equal tension, the inside of the rim should be examined, and any spoke ends projecting beyond the surface of the nipple heads filed off so that they cannot penetrate the tube.

The Chain.—The chain should be taken off, cleaned by soaking in paraffin and brushing well with an old stiff brush, hung up to dry, and then treated with russian tallow. To do this properly, melt some russian tallow in a shallow tin dish, just sufficient to cover the chain. Coil the chain, put in the tin of tallow, and stand on a stove, or place in a warm oven for an hour or so. Then hang up the chain to drain off superfluous tallow whilst warm, and wipe the chain with a cloth. This will thoroughly lubricate the chain in every link and rivet, and will last for a considerable time. The outside of the chain may be brushed over with graphite or blacklead, if the machine is not fitted with a metal gear-case. Should an oil-bath gear-case be fitted, the old oil should be emptied out, then cleaned out with paraffin, and fresh oil put in.

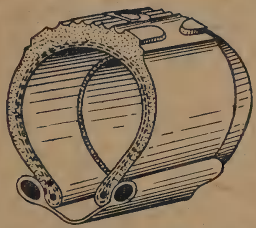
Free Wheel.—The free-wheel clutch should be cleaned by running some petrol or paraffin oil through it until the liquid runs out fairly clean; then let the petrol drain out, and lubricate with good oil. If the clutch runs very stiffly after being cleaned and oiled, it has probably been badly fitted on the hub. When the clutch is of the ratchet type, it will always make a certain amount of noise compared with one of the friction type. It is not necessary to take the clutch to pieces to clean it. All parts, such as rollers, ratchets, springs, etc., for renewals may be obtained separately.

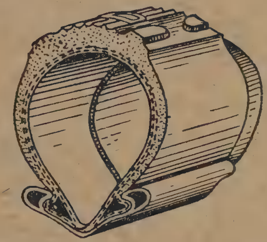
Free Wheel Clutch Slipping.—If a clutch slips when forward pedalling, it cannot be remedied by outside adjustment; it must be taken to pieces, and the cause of slipping ascertained. The fault may be one of the following: A worn-out clutch, oil being clogged and thus rendering the light springs used in free wheels inoperative, or the springs themselves may be weak. The remedy is: Before taking the cycle to pieces squirt some petrol or paraffin through the free wheel; with the machine on its side, revolve the wheel rapidly, and let all the liquid drain out, then lubricate with good oil. If this does not effect a cure, take the clutch to pieces and see what is wrong, and send to the makers for any new parts required. Gummed-up oil and wear are frequent causes of trouble.

Coaster Hubs.—For lubricating a coaster hub, ordinary oil is seldom suitable, as it simply runs out of the hub, owing to the heating of the brake. To overcome this difficulty a proper lubricant must be used. This is a non-fluid

oil melting at 356° F., made expressly for lubricating these hubs ; it can be bought of most cycle dealers. To lubricate, take down the hub, remove the brake clutch from the brake, and pack the interior of the brake with lubricant, applying a little to all bearings of the hub. Then fit together again, and if this is properly done, the hub will not give trouble for twelve months' ordinary running.

Handle-bar Grips, etc.—See that grips on the handle-bar ends are tight ; if not, heat an iron rod or poker in the fire, and place up the end of the bar to heat it, drop a little solid-tyre cement into the grip, and replace on the bar. The saddle may be preserved and improved by rubbing some castor oil well into the under-side of the leather.





Figs. 2 and 3.—Sections Through Cycle Wheel Rims and Tyres, Showing Wired-edge and Beaded-edge Covers Respectively

The tool kit should be overhauled to see that all necessary tools and the repair outfit for tyres are in order.

Tyre Repairing.—This may be undertaken very profitably by the rider. A cover may often be saved from ruin if, when a slight bulge appears, it is at once taken off and properly repaired from the inside, instead of waiting until it develops and finally bursts.

Tyre-repairing Outfit.—The outfit for repairing cycle tyres should consist of a tube of rubber solution, some french chalk, canvas or fabric for repairing the cover, glasspaper, valve rubber, and sheet rubber for patching the punctured tube. Such outfits can be purchased from any cycle repairer or stores, and range in price from fourpence upwards ; but a better and far cheaper plan is to buy the articles separately, especially if an old tube is available for use as patching rubber ; cut up the tube at the seam, and then into round patches of various sizes.

Removing Tyre Covers.—In a wired-edge cover the length of the wire is such that the cover is held in place within the rim, yet it may be removed without much trouble when so desired. In the case of the beaded-edge tyre the cover is, in a sense, dovetailed to the rim by the internal pressure of air bearing on the heel of a wedge-shaped endless band. This will be found clearly illustrated in Figs. 2 and 3 below.

To remove a wired-on cover, take off the valve cap and valve spindle, so deflating the tube, turn the wheel so that the valve is uppermost, undo the thumb nut, lift the wheel off the ground for about 1 in., and, pushing the cover from the worker, put the wheel on it, so as to hold it in position. Next select two well-worn pennies or other large coins, or the handle of a spoon, or other convenient tool ; push one between the rubber cover wire and the rim, about 2 in. from the valve, but be very careful not to nip or cut the tube. Then push in the second about 3 in. from the valve. The coins do not go in more than $\frac{1}{8}$ in., and are therefore not liable to injure the tube. Bear down on the two coins for leverage with two fingers of one hand, while pushing back the wire on each side with the other hand ; the tyre will then come off.

Beaded-edge covers are so easily removed that special instructions are unnecessary.

Repairing Inner Tube.—Suppose that the cover has been removed from the rim. Examine it both inside and outside for thorns or flints, remove the inner tube, and slightly inflate it. Have handy a bowl or basin containing water, immerse the tube in this for about 6 in. to 8 in. at a time, slightly stretching; go carefully round the tube until a leakage is manifested by the air bubbles rising to the surface. Now mark the puncture carefully with an indelible pencil, and select a patch large enough to cover the puncture. For a mere pin-prick a round patch about $\frac{5}{8}$ in. in diameter answers; for a burst, allow 1 in. at each side for overlapping. Thoroughly clean the patch and the tube round the hole with glasspaper, cover the parts with solution, and lay both aside for about ten minutes to get tacky. Then place the patch on the tyre and press down with the finger and thumb. Sprinkle a little french chalk over and around the patch, and try the tube in water again to see if there is still any leakage.

Repairing Leak at Joint. — Should there be a leakage at the joint, it will be better to take it apart rather than try to patch this up. With a brush apply a little benzoline (benzine) to the joint, keeping the tube slightly stretched, and on contact with the solvent the old cement will be dissolved and the tube will be found to separate. Turn one end inside out for about 3 in., clean it, and put some cylindrical object of a suitable size into the turned-back piece. Be careful that the tube is not twisted. Clean the outside of the other end and draw this end over the other one to within $1\frac{1}{2}$ in. of the extremity of the first one. Then coat with solution and lay aside to get tacky. Double one end back over the other, and allow sufficient time to dry. Then remove the cylinder from the tube, and pull the inner tube out straight; the joint is now complete.

Re-seating the Valve.—If the inner tube has suffered badly in the way of punctures round about the valve, or is found to leak under the old seating, it is best to select a new place in the inner tube for the seating. To remove the old valve, take off the two lock nuts and plug, unscrew the nut, and take off the metal washer; the valve stem now can be easily pulled out. Solution over the hole a patch a little larger than the old seating. When the new position of the valve has been selected, thoroughly clean a place on the inner tube about 3 in. by 2 in. with glasspaper. Now cut from a piece of patching rubber an oval-shaped piece about the same size for thickening the tube, make a round hole in the centre of each about $\frac{1}{8}$ in. in diameter, and solution the patch to the inner tube, taking care that the two holes come together. Wet the valve stem, insert it in position, put on the metal washer, and screw up the nut, so as to make an airtight joint.

Outer Covers.—Examine the insides of the covers for any damaged places in the canvas. If so, clean with benzoline and solution on a piece of prepared fabric much larger than the damaged part.

Replacing Covers.—Again place the valve hole at the top, and with the wired edge in position underneath drop the valve socket through the hole, and screw on the thumb nut. Next tuck in the tube, and replace the wire, beginning at the valve and always working towards the machine, because at the final strain the worker is free from the forks. If a tyre has never or seldom been removed it fits very tight, and then the easiest way is to lash one side of it in position so that it will not slip out, and tuck in the tube and wire as far as is possible with ease; then pump in a little air to prevent nipping. With one hand hold the wire, and with the other press it into the channel of the rim. Try again with two hands; again act as before, and so on, till at last the tyre slips into place. At this point many go wrong, for they pump up and ride off. The milled nut must be loose and the wired edge pressed into its groove evenly all round, without the inner tube in any place lying between the rubber and the metal rim; otherwise undue pressure may cut a large hole both in the tube and cover. When the wire fits properly all

round, tighten up the valve and replace spindle, etc., as before.

Fixing Puncture-proof Bands.—When fitting a puncture-resisting band to a cover, remove all the dirt and mud possible with a good stiff brush, rub a rag or cloth dipped in benzoline round the outer cover, and roughen the tread of the cover with a file or rasp. The tyre is now ready to receive its first coat of solution. Apply the solution with a small brush, with which it can be rubbed into the cover better than with the fingers. While the solution is drying or getting tacky, clean the band and cover it with solution in the same way, taking special care that the solution is well applied round the edges of the band. By this time the cover should be ready for its second coat of solution. This should be rubbed on a little lighter, so as not to disturb the first coat. Give the band another coat, and allow this to remain for about an hour to get dry. The band will now be ready to fix on the cover. First roll up the band, apply the end of it to the cover, and unroll the band about 3 in. or 4 in. at a time on to the tyre. If the band is too long, cut off the remainder, so that it makes a neat joint. Press down the band from the centre and work to the edges, to remove all air bubbles.

Lighting a Bucket Fire

A "JOINTER'S" fire is contained in a bucket, and is commonly used in the open air. Long years of experience have shown that coke is practically the only suitable fuel for the above purpose, as it avoids smoke, etc.

Coke, when added to a coal fire that has been burning for some considerable time, will more or less readily ignite; but to start a fire with coke only, in any of the ordinary types of fireplace or range met with in domestic households, is practically impossible. The same statement applies to a very large extent to lighting the jointer's brazier in the open air. Merely throwing in paper, wood, coke, and then applying a match will not accomplish the desired result, even when that dangerous expedient of emptying paraffin over the fire is resorted to.

Generally speaking the best and quickest mode of procedure consists in first covering the bottom of the bucket with a layer of coal broken to the size of a walnut or small egg; cover this coal with crumpled paper, or, better still, wood wool or shavings; then place in the wood, about six or twelve pieces about 1 ft. long, by, say, $\frac{3}{4}$ in. These sticks should be so placed on end in the fire bucket as to form a very crude resemblance to an army bell tent, or cone; that is, the lower ends of the sticks should be spread out well towards the sides or inner periphery of the bucket. Then lightly arrange the coke, which should be in lumps varying in size from, say, a walnut to a cricket ball, round the cone formed by the sticks. Pile on the coke until the bucket is full, leaving the upper ends of the sticks protruding through the top of the mass of the coke, or just visible at the top. A small quantity of paraffin may now be poured over the whole, though a little practice in laying will speedily enable one to secure perfectly certain and reliable results without using this inflammable stuff.

On applying a lighted match at the bottom, the flame will immediately run up the wood core or centre of the fire; and as the wood is consumed, a central flue is formed, accompanied by the rapid ignition of the surrounding coke. Ultimately a glowing crater of coke is formed in the centre, which forms a good nest for the metal pot.

Rubber Stamp Making

Rubber stamps are universally employed for printing names and addresses, monograms, etc., and for numbering, dating, labelling, cancelling, and checking documents, etc., where the same words or sentences or combinations require to be used a number of times. It is also possible to produce rubber stamps that will give a facsimile of a signature which may be used for endorsing all but official documents.

Fig. 1.—Setting Type

Fig. 2.—Type Set Ready for Frame

It is not surprising, therefore, that the manufacture of rubber stamps has become a flourishing little industry, but without entering into the professional aspect of the manufacture of rubber stamps, the subject may be approached from the amateur's point of view to see how rubber stamps may be made at small cost.

Setting up the Type.—The best method of proceeding is to have steel type and to take a cast from these in type metal, but as this would be somewhat costly the amateur is generally content with ordinary printers' type, which may be bought, together with some spaces or blanks, from a dealer in printers' materials. The kind of type required will depend upon the number of letters to be included on the stamp, and also upon their disposition, but for most purposes small capitals will be suitable. The type should

be set up in a type-holder (Fig. 1), and of course reversed—that is, beginning with the last letter of the line and spelling backwards. Each line of type should be divided from the next by a lead (a piece

Fig. 3.—Type Wedged in Frame

of thin spacing), cut to the whole length. When all the letters are put together, spaces should be put in to fill up the blanks and the whole tied together (Fig. 2). The type is then transferred to a metal box or forme, and tightly wedged so that it cannot move (Fig. 3). It will be found that the ordinary spaces are much below the level of the type; therefore, it is necessary to fill them in until they are level with the bottom of the letters. This difficulty could be obviated by having special spaces cast of a proper length, but the amateur may use pieces of ordinary rubber of about $\frac{1}{8}$ in. thick, which may be cut to fit the blanks and pushed into position.

Making the Mould.—A piece of stout tinplate about 6 in. long and 1 in. wide is now cut and bent into the form of a rectangle which will enclose the type, leaving a small equal margin all round. This should be fixed in position so that it cannot move, and should be wired to hold it together (see Fig. 4). The inside of the mould and the top of the type are now lightly oiled with a soft brush to prevent the plaster used in the next operation from sticking to it.

A little plaster-of-paris is now made into a soft smooth paste with cold water, and then with a knife or spatula pressed

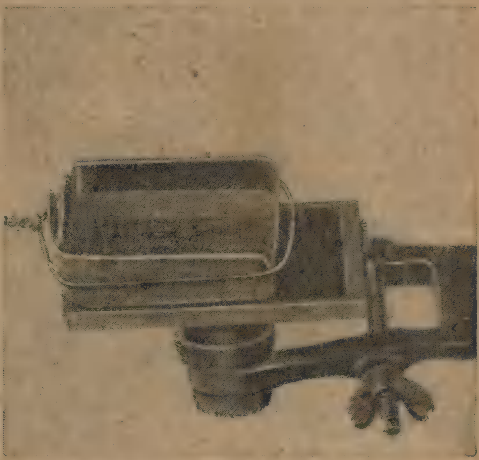


Fig. 4.—Mould Ready for Casting

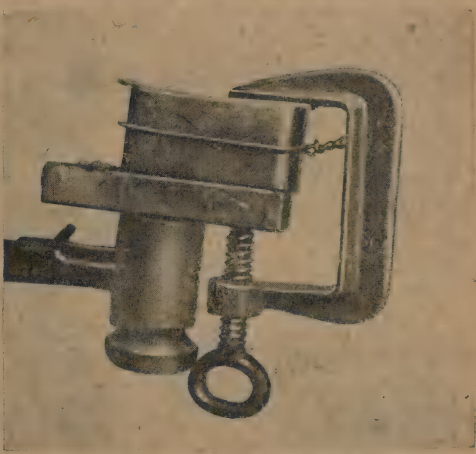


Fig. 5.—Mould in Clamp

well into the mould until it is rather overfull; upon the plaster is placed a piece of tinplate and the whole is submitted to pressure either by means of a clamp (Fig. 5) or in a press. After standing two or three hours the pressure may be released, the tinplate may be taken off and the mould carefully lifted straight

upwards, when it will bring the plaster cast with it. The wire is then removed, the tinplate opened out and the plaster cast removed.

The cast should be dried very slowly at first, then in an oven at the temperature of boiling water till it is perfectly dry.

The cast may now be carefully faced and cut to a proper size with a sharp chisel (Fig. 6). After this is done a piece of tinplate about $5\frac{1}{2}$ in. long and $\frac{3}{4}$ in. wide should be cut and bent so as to enclose the cast, to which it is held by binding wire, thus forming the mould for the rubber stamp (Fig. 7). On this the letters are sunk and in their right position.

Fig. 6.—Trimming Cast

Fig. 7.—Cast with Surround to Form Mould

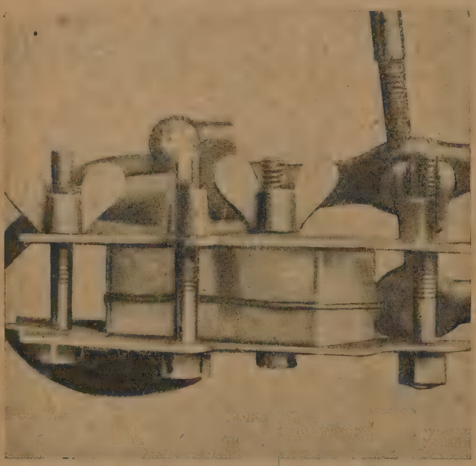


Fig. 8.—Mould and Rubber in Clamp

Moulding the Rubber.—A piece of mixed uncured (unvulcanised) rubber sheet should be cut of such a size that it requires pressure in order to get it into the mould. It needs to be warmed a little to render it more pliable, after which it may be pressed into the mould, a piece of tinplate just fitting the mould should be placed upon it, and the whole put into a small clamp, which should be screwed down tight (see Fig. 8). The clamp is made of sheet brass, and has four small bolts with wing nuts passing through holes in the two plates. The brass should not be allowed to come into contact with the rubber, as copper and copper alloys exert a detrimental action upon rubber, especially when heated.

Curing or Vulcanising.—The mould in its clamp should now be placed in a vulcaniser, in which the heat will cause the rubber to combine with the sulphur with which it has been mixed, thus forming a durable substance. There are several types of vulcaniser, but those here described are more particularly suitable for amateur work. Fig. 9 shows an autoclave, which consists of a stout copper or gun-metal

cylinder closed at the bottom, but open at the top, fixed in an iron sheath which serves as a stand or support. The top, gun-metal, is provided with small openings, one for a safety valve, one for a pressure gauge or thermometer, and another for a blow-off valve. If a pressure gauge is used the temperature is easily calculated. A heavy iron bridge clamp is fixed to the sides of the cylinder, but falls back when not in use for the purpose of lifting the top ; when in use a bolt on it is screwed down tight so as to hold the cover firmly in position against the pressure, the whole being made tight with a ring of lead. This autoclave may be provided with a false bottom, but if such is not the case a ring of brass is made rather smaller than the cylinder, and upon this is placed a circle of perforated metal for supporting the article to be heated. Fig. 10 is a section of the autoclave.

When the work is ready for the autoclave a little water is put in the bottom of the cylinder, the object to be heated is placed in, the cover is put on, the clamp brought over and the bolt screwed down tight ; then the autoclave is heated with

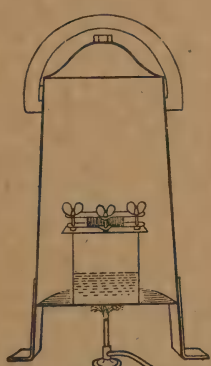


Fig. 10.—Section Through Autoclave

a bunsen burner. Very quickly the pressure rises and as soon as a temperature of about 290° F. (about 143° C.) is reached steam blows off through the safety valve, which has previously been set for that purpose. After the requisite length of time, which may be 10 minutes to 30 minutes, the burner should be turned out, the blow-off valve opened, and as soon as the pressure has run down to zero, the cover may be taken off, and the clamp,

Fig. 9.—Autoclave

containing its now vulcanised or cured rubber stamp, removed.

Another form of vulcaniser is shown at Fig. 11, this being a hot-air bath constructed of stout sheet copper or iron and heated by means of a bunsen burner. It is provided with a thermometer, and also a thermostat, which keeps the temperature constant by regulating the size of the flame, the gas having to pass through the thermostat to the burner.

In place of the air bath, an oil bath may be employed, this being similar to the former in construction, but being jacketed and the jacket being filled with oil. In either case it is necessary to place the object to be vulcanised on a shelf inside the oven as near the thermometer bulb as possible, for if it should be placed on the bottom of the oven, the temperature there being much higher, it would certainly be ruined.

The time of heating will be about 10 to 30 minutes at from 260° F. to 295° F.

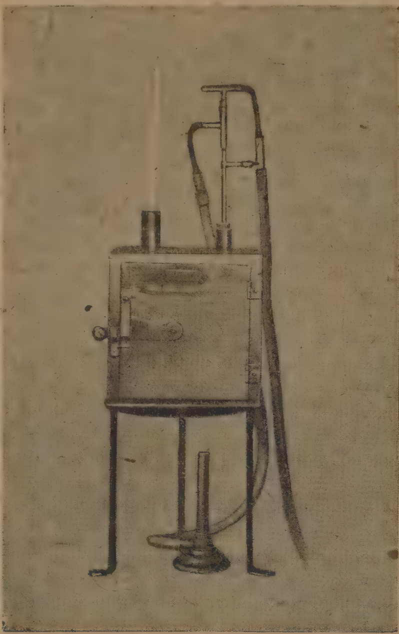


Fig. 11.—Hot Oven for Vulcanising Rubber Stamps

The rubber stamp is now removed from the mould and is ready for fixing on its support (Fig. 12)

Fixing Stamp on its Support.—Rubber stamp handles have flat brass plates in various shapes and sizes. The face of the brass is usually left rough to give a better " key " to the cement, this being of the solid kind used for cementing on bassinette tyres, and consisting of a variety of marine glue. The brass is warmed slightly in a burner, the tyre cement rubbed on, heat again applied, and the rubber stamp pressed into position. If properly done the cement will hold it quite firmly (see Fig. 13).

Pads and Inks.—A pad may be made by cutting a piece of hardwood 4 in. by $2\frac{1}{2}$ in. by $\frac{1}{2}$ in. and planing it smooth. This should be covered with tinfoil, glued on. Upon this should also be fixed a piece of thick but close flannel, gluing only the under-side so that the top is not fixed down to the wood, but is simply stretched across it. Over this may be fixed a piece of fine cotton.

With reference to the inks, the usual colour is violet, which is obtained with methyl violet, but any colour of ink may be employed using the appropriate aniline dye. The following may be taken as examples : — (1) Methyl violet 1 oz., glycerine 16 oz., water 8 oz., rectified spirit 8 oz. ; (2) Aniline blue $\frac{1}{2}$ oz., glycerine 16 oz., water 16 oz. ; (3) Gentian violet 1 part ground with six parts of glycerine.

Fig. 12.—Mounting Rubber Stamps on Handle

Fig. 13.—The Finished Stamp

Facsimile Autograph Stamps. — In making rubber stamps of signatures, particular care in all the processes is essential. Coat a piece of flat metal plate evenly with melted beeswax to a depth of about $\frac{1}{16}$ in. Before this has got quite hard write slowly what is required; make the pencil or stylus penetrate to the metal, quite through the wax, from end to end of the autograph. Clear out any shavings or chips of wax that may clog the writing. Sift some plaster-of-paris through fine muslin; dry the powder in an oven, making it hotter than the hand can comfortably bear. Grind it up with a pestle and mortar to remove all traces of lumps, then sift again. Replace in the mortar and add enough water to make a thick cream, using the pestle to get thorough mixture and to leave no unwetted powder. Pour the cream upon the wax autograph and pat it with a light stick, so as to force the cream into the grooves of the writing. When the cream has set quite hard there should be a perfect facsimile. A similar procedure will obtain the true mould from the plaster facsimile, and the rest of the work is precisely as already described in this chapter.

Dry Rot in Floor Timbers

There is only one remedy for effectually dealing with dry rot—the entire removal of the floor joists and plates, and reinstatement by well-seasoned timber, with ample ventilation provided by continuous currents of fresh air, broken up and so distributed as to equally affect all parts of the floor, as the corners and sides are very liable to become affected with rot. Allow a clear air space of about 9 in. below the floor, and cover the ground underneath with a layer, not less then 3 in. thick, of good concrete.

Linoleum, when fitted closely round rooms, is often found to be a contributory cause of dry rot, where the lightest suspicion of dampness is apparent. It excludes the passage of air, and if used at all should have several inches of margin round the room. If closely fitted, it should be frequently examined, and taken up for the purpose of airing the boards.

To remedy dry rot, remove all timbers affected, including skirting, grounds, plugs, blocks, etc. Take down fender walls, and, if there is no concrete, put 6 in. of good cement concrete over the ground. See if there is any dampcourse, and, if so, whether it is above ground level outside. Secure through ventilation by at least three air bricks back and front, of 9-in. by 3-in. iron "School Board" pattern, in preference to terra-cotta; and if there is a solid floor in a rear room, carry 3-in. iron or stoneware pipes under to outside wall, as a "dead end" is often the source of the trouble. Even with a boarded floor in an adjoining room there may be a solid partition beneath the floor; if so, knock out a few bricks to secure passage of air. The new fender walls must be built "honeycomb" to secure effective ventilation.

Coat all brickwork to top of skirting, back of door jambs, where affected, concrete and fender walls, with Solignum or Carbolineum, used hot, and well worked into joints of brickwork. (A solution of corrosive sublimate is even more deadly to the fungus, but it is a dangerous poison.) Similarly coat all round new joists, sleepers, etc., including ends, and, when fixing, keep ends an inch clear of the walls. Coat under-side of floorboards and keep edges and ends $\frac{3}{4}$ in. from wall. Also treat in similar manner back of skirting, door jambs, and any grounds, blocks, etc., next wall. Care must be taken to keep the Solignum clear of faces of any wood to be painted, and from splashing the plaster of wall.

Tinning Kitchen Utensils

Copper and iron pans used as cooking utensils often require to be re-tinned. The process of tinning in both new and old work is identically the same, but with the latter more time has to be spent in cleansing the metal, and thus preparing it for its coating of tin. New work requires only to be treated with spirits of salt previous to the application of the tinning fluxes.

TINNING COPPER VESSELS

Cleaning.—The usual run of copper utensils, such as stewpans, stock-pots, bain-maries, gravy strainers, etc., are mostly cleaned first by burning off—that is, placing the vessel over a fire and heating it up gradually until all the fat is burnt off from the pan and under the handles. This burning may be done over an ordinary forge fire or in the flame of a gas blow-pipe, the vessel being moved about so that the grease from the whole surface is burned off. If the pan is allowed to become too hot, the copper will soften, and require to be hardened by hammering all over when cool.

The grease may be removed without burning by immersing the vessel in a warm solution of ten parts water and one part caustic soda. To prepare the solution boil the water and stir in the caustic soda with a glass rod. Remove the pan from the solution, quickly rinse in cold water, again immerse in the solution, and then again rinse in water, rubbing with a pad of tow or a fibre brush whilst in the water. All grease should now have been removed.

After the fat has been burnt off or otherwise removed, the next step is to immerse the pan in spirits of salt (muriatic acid) contained in an earthenware vessel. If the pan is very dirty, make it hot and cool it in the acid, being careful not to inhale the fumes that will be given off. Still more vigorous cleansing will be required now, if the pan was overheated when burning off; alternate immersions in nitric acid and spirits of salt, and a scouring with coke-dust, salt, etc., between each immersion, being necessary. Having immersed the pan in the spirits of salt, stand it in the open air, and with a mop of old sacking tied on to a stick, keep it well doused with the spirits until the pan is clean; this may be in a long or a short time, according to whether the pan was very dirty or only slightly so.

Scouring.—When the pan is clean, rinse in water and scour it with a mixture of equal parts of fine coke-dust, iron scales, and salt, applied with a piece of tow. This scouring must be done very thoroughly, so that all parts of the metal will afterwards take the tin and render unnecessary any touching up with solder. It requires practice to know when a vessel is clean enough for tinning. Attention should be given to the handle and any fittings. The heads of the rivets that secure the handles should be scraped quite clean with a piece of wire, one end of which has been hammered to a chisel

shape. If the handle is then loose, tighten it up by hammering the rivet-heads upon a mandrel.

Tinning.—The pan is now ready to be tinned. The outside and those parts not to be tinned must be protected from the oxidising action of air when the metal is hot by wiping with strong brine (salt and water) or with moist whiting, or with a mixture of salt, whiting, and water. The border or rim of a copper stewpan should not be so coated, as it is to be tinned. Allow the coating to dry before proceeding further. Rinse the surface to be tinned with clean chloride of zinc (killed spirits), and sprinkle with finely powdered sal-ammoniac ; these fluxes prevent the oxidation of the copper and tin when hot. Take care to prepare the rim for tinning ; the depth of the latter may be marked round with a pair of compasses. The pan should now be heated uniformly over a forge fire or large blow-pipe flame until a stick of pure tin, which is rubbed upon the inner surface, melts at the end. The molten metal is quickly diffused over the parts to be tinned with a pad of wool or tow ; take care to properly tin the rivets, or they might possibly leak. If the vessel is thoroughly clean there will be no difficulty in tinning and wiping it out in one heat. With cotton-wool and a little sal-ammoniac wipe out very carefully, and then cool the pan in plenty of clean water. If the pan were allowed to cool slowly out of the water, it would have a dull, discoloured appearance, instead of a silver colour.

Small patches, where the tin did not adhere, will become evident if the copper was not well cleaned. These patches may be touched up by well rubbing with a lump of sal-ammoniac while the tin is in a molten condition. On cooling, again immerse the pan and wash off the burnt whiting which was applied to protect the outside of the pan. With a wisp of tow scour the inside with silver sand, rinse in water, and wash the outside with a solution of cyanide of potassium ; this is a deadly poison, and should be applied with tow on the end of a stick, keeping the hands free from it. If the pan was not made too hot in tinning, this solution will instantly remove all dirt, and give the copper its original bright colour. A piece of cyanide about as large as a walnut is sufficient for a pint of water.

After cleansing the pan with the cyanide solution, rinse with water, and clean the rivets with silver sand, using a brush and a sharp-pointed stick. When the handle and rivets are thoroughly clean, scour the outside of the pan, and then with a fresh piece of tow and fresh silver sand finish off the inside, finally removing all stains from the fire, flux, etc. The sand should be worked round in one direction only to give a neater appearance ; an even mark on the bottom of the inside is made by rubbing with a cork.

When vessels of intricate shapes are to be tinned, and it is found impossible to wipe them out as before described, they are heated to a temperature a little above the melting point of tin, flux is thrown in as usual, and the molten tin is poured in from a ladle, the article being then tilted about over the fire or blow-pipe flame until the whole inner surface is coated ; superfluous tin is then poured out. Another method is to coat the outside with whiting, and, holding the vessel with a pair of tinner's tongs, immerse it in molten tin, tilting it so as to allow the spare tin to drain out.

TINNING IRON VESSELS

Wrought-iron vessels are re-tinned in practically the same manner as are copper ones. First scour the article with sand and water, immerse in warm dilute hydrochloric acid until the surface to be tinned is clean and free from black patches, and then scour again with pumice-stone and water. Then proceed exactly as with the copper pan, though if it is convenient the vessel may be immersed in molten tin instead. When immersing the pan, the open top should be held farthest from the worker, as the molten metal, when it comes into contact with the damp surface, boils and "spits."

Mounting and Unmounting Photographs

MANY pitfalls are to be met with in the apparently simple task of mounting or unmounting photographs, owing to the delicate nature of the prints, and their susceptibility to certain impurities commonly present in mounts and adhesives not specially prepared for photographic use. This chapter has been especially written for the handyman who knows nothing whatever of photography. The serious photographer purchases appliances, mounts, and special adhesives for the work, but it is here assumed that the reader has no desire to do so, having perhaps but one photograph with which he wishes to deal.

Unmounting a Photograph.—The task of unmounting a photograph is far more difficult than that of mounting one. A person often wishes to remove a picture from its mount, either because the mount has become dirty or damaged, or it does not suit one's ideas. Fashions in mounts change frequently, but it is not advisable to pay too much attention to them.

The unmounting of a print is made all the more easy if the photographic process is known; but assuming it is not, the photograph attached to the mount is simply laid in clean cold water until the photograph comes easily away without any pulling. Cold water cannot hurt any plain (uncoloured) photograph. If the mount is a very thick one part of it may be torn away, or split down from the edges, before and even during the soaking, in order that the water may the more quickly reach the adhesive at the back of the print. In some cases photographs have been hardened, glazed, or made more or less impervious to damp or water, in which event water will get more easily at the adhesive through the back than from the front of the picture. The time for soaking depends upon the quality of the mount, print and adhesive. Two or more days may elapse before the print will leave the mount, whereas in some cases an hour, or perhaps less, will be enough. The original mount will in all cases be destroyed.

While the cold-water treatment serves in most cases, there is, however, one important exception, namely, those prints that have been "dry mounted." Dry (or hot) mounting is used nowadays very largely by the highest-class firms, and those doing immense quantities of commercial work. Photographs upon show-cards, etc., are nearly all dry-mounted. The process consists of placing between the dry photograph and mount a piece of tissue paper coated on both sides with a solution of shellac, then applying heat and pressure with a hot flat-iron or in some other way. The heat melts the shellac, and the picture becomes firmly attached to the mount. To unmount these pictures it is necessary to apply dry heat so as to soften the shellac, and this

may be done by warming the back and front of the picture before a fire.

In bygone days it was customary to place photographs and mounts in hot water

Fig. 1.—Pulling Mount Off Print : Safe Method

in order to separate them, and hot water may be used to-day, but only if the worker is certain that the picture is upon what is known as albumen paper. From about the year 1860 to about 1890 almost every photographer used albumen paper for his photographs, so that most pictures of a brown tone taken during that period may be placed in hot water, and the operation of separating mount and picture facilitated. Albumen papers are now quite out of date, their place having been taken by gelatine papers, which are ruined in warm water —hence the necessity for prolonged soaking in cold water in cases where the kind of paper is unknown.

When a picture and mount have been soaking for some time, the process of separation may be assisted mechanically, should the picture not leave the mount of its own free will ; but the greatest caution is necessary or the print may be torn. The mount should always be pulled or torn *from the print*, and never the print from the mount. The best plan is to lay the dampened print and mount upon a flat surface, print side downwards, and to bend back (or break) the mount from the print. If a finger is kept on a loosened corner of the print and the latter pressed down, all the breakages or tears will be in the useless mount (see Fig. 1). If, on the other hand, the picture is laid face upwards, and any attempt is made to pull back the print from the mount, the picture will be the first to suffer (see Fig. 2). When the print is released from the mount it should be soaked in water, and any adhesive or bits of the mount removed from the back by rubbing them off with the finger tip.

To dry a print, lay it face upwards on a clean piece of white blotting-paper, or, better still, on a clean duster, and allow it to dry naturally. Any attempt to hasten drying, either by applying heat or by placing between blotting-paper, may possibly ruin it.

Unmounted prints, both those quite new and those taken from mounts, often require to be flattened or straightened out ; photographs have a habit of curling badly, and any other than the proper method of flattening them may cause a tear. The correct method is to place the print on a piece of glass or smooth board (a table will serve), making it as level as possible and having the face or curled side downward ; a flat ruler is placed at one end or corner and firmly pressed down. Next, the corner or edge nearest the ruler is held firmly, and the

Fig. 2.—Pulling Print Off Mount : Unsafe Method

whole print drawn sharply *under* the ruler, the latter being kept stationary (see Fig. 3). The process may need to be repeated if the print is badly curled.

Mounting.—In mounting a photograph properly the two chief considera-

tions are the mount and the adhesive, because should these contain any impurities the print may fade very quickly. Most cases of fading may be blamed to

Fig. 3.—Straightening Curled Print

carelessness in fixing and washing the print properly when making it; but many cases of fading may be traced to the method of mounting or to the mount itself. It is advisable to purchase a specially-prepared mount or to use really good cardboard or stout paper. Common cardboard often contains chemicals (particularly sodium hyposulphite) that cause fading. The darker shades of card are generally the purest, but perfect white mounts, as well as those of any other colour, may be bought from photographic dealers for a few pence.

The adhesive or mountant should not consist of office gum, flour paste and other rough-and-ready adhesives commonly used in the household; these will stick the print to the mount, it is true, but their acidity or other imperfections will cause the picture to fade. The most commonly used mountants for photographs are starch, dextrine and gelatine. Starch is used by the majority of professional photographers. Any kind of ordinary laundry starch will serve.

Rub up a little starch with cold water in a small basin until it forms a very smooth, cream-like paste; pour boiling water upon it, stirring constantly until it jellifies. There is a little knack in doing this, and should the mixture not jellify properly it should be thrown away and a fresh start made; or the mixture may be boiled. Another plan is to rub up 1 part of starch into a paste with 2 or 3 parts of cold water; have ready a saucepan containing 6 to 8 parts of boiling water, pour the rubbed-up starch into it, stirring well all the time, and allow to boil for five minutes (a "part" named above may be an eggcupful). All starch mountants should be free from lumps, allowed to cool and the top skin taken off before use, but they should not be kept longer than two days.

There are two methods in common use for the mounting of photographs—the "wet" and the "dry." By the dry method, however, is not meant the hot or shellac system already referred to, that process being almost out of the question for inexperienced workers. The surfaces of most photographs are soft and sticky when wet or damp, and may be ruined if roughly handled or anything is allowed to become attached to them.

To mount a print by the wet process first place the print in clean cold water, have ready a piece of glass (the bottom of an enamelled pie-dish, Fig. 4, serves as well, if large enough) and thoroughly wet it. Then place the soaked picture face downwards upon it and dab off the

Fig. 4.—Using Enamelled Dish for Supporting Print

superfluous water from the back with a clean duster or piece of blotting-paper. The wetting of the glass or dish bottom is absolutely necessary. If the soaked picture be placed face downwards upon a dry surface it will become firmly

attached to it because of its sticky (gelatinous) nature, and, in most cases, the picture will be ruined because of the difficulty of removing it. If, however,

Fig. 5.—Sponging Off Paste from Print

the "support" is well wetted the picture will not adhere to it, unless, of course, it is allowed to remain for an unreasonably long time—that is, until some of the water evaporates. After the back (plain paper side) of the picture has been dabbed or blotted fairly dry, a thin coating of the starch mixture is evenly applied, either with a brush (a shaving brush is excellent), piece of sponge, or the fingers, care being taken to see that no stray hairs, etc., get on to the back of the print, because any hairs, grit, or lumps of starch will cause the picture to appear uneven, as they will show when dry. The drawback to a sponge is the grit that is liable to come out of it. Perhaps, after all, the spreading of the starch with the finger tips is the best, even though it be the most messy, as any grit or other foreign substance is easily felt. The print is lifted carefully and placed in its proper position upon the mount. As starch dries very slowly the picture may be rearranged if necessary, and perhaps "slid" about until it is in its proper position and flat. When correctly placed, the print is wiped over a few times with a soft wet sponge (see Fig. 5), at the same time pressing the print down upon the mount very gently and wiping away any of the starch that may exude. It will be necessary to wash the sponge several times if starch does exude, otherwise the picture will dry "smeary." After sponging well, the mount, with the picture upon it, is put aside to dry.

The dry process of mounting is largely used for highly glazed prints (which would lose their gloss if wetted), but any photograph may be mounted in the same way. Dry mounting consists in placing the print face downwards on a piece of paper, brushing on the starch, and applying the print to the mount in the usual way. The print will invariably curl as soon as the starch is applied, and efforts should be made to keep it flat while the starch is being distributed, either by pressing upon it with the finger tips or placing a coin at each corner of the print. When the picture is attached to the mount it may be covered with a sheet or two of clean blotting-paper, then rolled with a rolling-pin, or even passed through a wringer-mangle, and finally dried under pressure. The surface of the photograph not being wet and sticky, no dry material will damage the picture. If, however, too much starch is placed on the back of the picture, there is a danger of its being squeezed

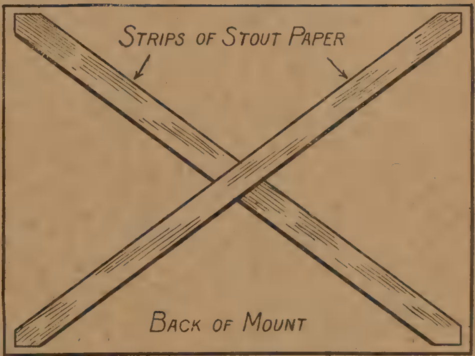


Fig. 6.—Paper Strips at Back of Mount to Prevent Curling

out when pressure is applied, and it is therefore advisable to examine the edges and to wipe away any exuded mountant before pressing. Without pressure, freshly mounted dry prints are apt to come away from the mount during drying.

A little of the glaze on the picture is lost because the dampness finds its way to the front from the back.

In cases where it is desired to mount a very highly-glazed photograph without the slightest loss of gloss, starch should be displaced by seccotine, tyre cement, or other form of liquid and quick-drying glue. The dry print is placed face downwards and as narrow a border as possible of the glue placed around the edges. As such adhesives dry rather quickly no time must be lost in applying, in placing the print on its mount, and in putting under pressure.

Mounted photographs are apt to curl very badly, and the larger the picture the more pronounced the curl. Framed prints cannot curl, but unframed prints stood on mantelpieces, pianos, and such places often become unsightly, particularly if the atmosphere is very warm and dry. The curling of mounted pictures may be prevented by pasting two strips of stout paper diagonally across the back of the mount, from corner to corner in the form of a cross (see Fig. 6). Such strips counteract the "pulling" power of the print on the other side of the mount and the picture keeps flat, or at least nearly so.

When small pictures curl it is better to flatten them under pressure, as any attempt to bend them straight by reversing the curve in the hands may cause the mount or photograph to crack. Pictures made upon what is known as collodion-paper often crack when bent back, and such accidents cannot be remedied.

Special Precautions against Cockling.—Cockling or wrinkling of photograph and paper is the ever-recurring trouble when the paste-in, instead of the slip-in, type of album is employed. Thin and porous paper is certain to cockle, whatever mountant is used. If a mountant is used containing water, a difference in stretching between the print and the mount is sure to occur, this resulting in cockling. Hence, the most satisfactory preparation is either an alcoholic solution of gelatine or a solution of indiarubber in pure benzine. There is, with the former solution, considerable difficulty in getting the print to lie perfectly flat, even, and free from lumps and wrinkles, whilst the rubber is liable to perish and then the photograph will peel off. On the whole, the gelatine solution is to be preferred, but it should be applied only to the extreme edges of the print. To do this neatly, lay the dry print face down on a sheet of glass and place over it a pad of stout paper that will give the print $\frac{1}{4}$ in. of free edge all round. A narrow edging of thin gelatine solution may then be readily run round the exposed edge of the print. Quickly lay the print in position, and press well into contact, but not hard enough to squeeze out the gelatine.

Making Signs in Chipped Glass

Let it be assumed that it is desired to have a name on a chipped-glass background on the glass panel of a door. Procure a sheet of plate glass of the size to fit the framing, and have it ground by the sand-blast method or with coarse emery and water. Clean it thoroughly with a solution of soda, and when dry paint on the name in any oil paint. Now soak some Irish glue in water, and when swollen dissolve in a glue-pot, and smear evenly over the whole surface of the glass. Do this work in a warm room, and heat the glass before gluing. Lay the glass on a flat table, and keep the room the same temperature and free from draughts until the glue is quite dry.

Next cause a current of cold air to blow on the glass, or carry the glass into a draughty passage, and lay it on a table. The glue will contract and spring into the air in countless pieces, drawing with it

thin flakes of glass forming patterns of all kinds. No two pieces of glass will have the same design, some resembling ferns and others shells ; but there will be a certain conformity of design in each piece that is pleasing to the eye. The paint may now be cleaned off with turpentine, and the job is finished. The chief point to remember is to have the glass ground coarsely, in order to give a good bite for the glue. The second point is to be sure that there is no trace of grease on the glass, which would prevent the glue from adhering firmly. The third point is to dry the glue at a high and even temperature, and to cause the cold draught of air to blow on the plate as suddenly as possible.

A more striking sign can be done by following out this method on glass that has been veneered with ruby glass, and repeating the operation two or three times, until all traces of the red colour have disappeared in the chipped portions.

Making a Wood Harp

In a wood harp the sounds are produced by rubbing the gloved hand down the sticks (Fig. 1). For the foundation take a piece of well-seasoned deal, 6 ft. long by 6 in. wide, and about 4 in. thick. Plane this up to the size and shape shown by Fig. 2. The rods are $\frac{1}{2}$ in. in diameter when rounded up. The longest will require to be about 6 ft. ; all must be evenly planed and glasspapered. At $3\frac{1}{2}$ in. from one end of the foundation, bore a hole 1 in. deep with a brace and centre-bit. This hole should be slightly less in diameter than the rods. Bore similar holes right along the centre of the foundation at distances of $3\frac{1}{2}$ in. apart. Slightly taper one end of the rods, and, after dipping them in good hot glue, drive them well home with a mallet. For the stand, plane up a board 6 ft. by 10 in. by $1\frac{1}{2}$ in. to the section shown by Fig. 3, and screw it to the foundation from the bottom. Fig. 4 shows the end in section, B being the rod, C the foundation, and D the stand.

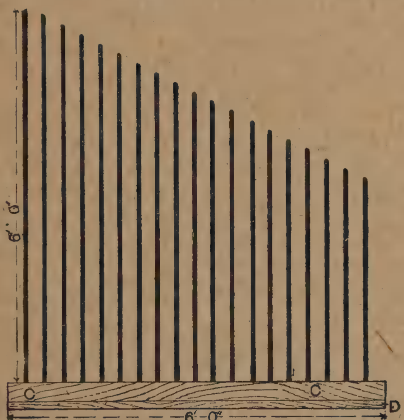


Fig. 1.—Wood Harp

Fig. 2.—Section Through Foundation Block

Fig. 3.—Section Through Stand

Fig. 4.—Vertical Section Through Wood Harp

When thoroughly dry, rub down with glasspaper ; then take an old glove of washleather and dust it well with powdered resin. Take hold of the longest rod with a light but firm grip, and draw the hand down. Try this until the best effect is obtained ; then proceed to tune all the other rods from this one by cutting them down very cautiously piece by piece.

Keep the wood harp very clean ; do not stain, varnish, or paint it. Never touch the rods except with the resined gloves.

Forming Plaster Mouldings with Templates

Templates for forming mouldings in plaster and cement are usually cut in zinc stout enough to withstand the strain of being drawn along the material after setting, and strengthened with a wood backing, mounted on a base or guide-piece. Expert workmanship is not called for in their construction, but the zinc profile needs to be accurately cut, and the guide rigidly secured to the wood backing, so that it may run truly.

A simple template for running straight mouldings is shown by Fig. 1. The zinc profile of the moulding is shown at A; it is secured by four or five tacks to the wood backing B, the front edge of which slopes away from the cutting edge of the zinc. The base C is sometimes termed the "slipper," and forms the guide in running the moulding. When the work is of any size, the rigidity of the template is further secured by strutting at the sides, as in Fig. 2, or at the top, as in Fig. 3.

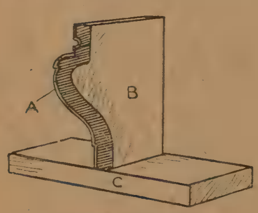


Fig. 1.—Simple Template

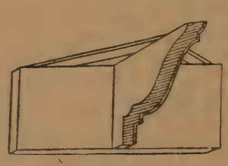


Fig. 3.—Template Strutted at Top

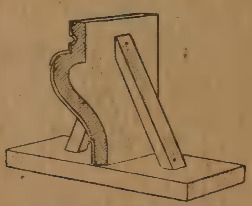


Fig. 2.—Template Strutted at Sides

Templating Straight Mouldings.—Any of the templates already referred to, with possibly slight variations in construction, would be suitable for running straight mouldings. Ceiling cornices and similar mouldings can be conveniently templated in position, a simple guide underneath a small moulding being all that is necessary. If the wall is unplastered, the laths will form sufficient support for the cornice moulding, but should the wall have been plastered, it may require supporting. One way of keying a cornice to a wall is by means of broad-headed nails driven in from 6 in. to 12 in. apart, and projecting not less than half the thickness of the moulding; before being used, the nails are soaked in boiling linseed oil, or given a couple of coats of brunswick black to prevent them from rusting. The nails are connected together with two or three lengths of stout tarred string, which will be found an effective key for the plaster. If the template employed resembles Fig. 1, a piece of wood should be fixed along the bottom at the front, forming a step that

moves along the guide (see B, Figs. 4 and 5, which illustrations show the template in place and, further, show its shape in section).

In practice, the ropes or strings are soaked in liquid plaster, and afterwards thick plaster is laid on to the rough shape of the moulding. The work is brought to a fair degree of completion by working a little at a time, as the greater part of the work of running the moulding is done before the plaster has actually set. Clean the template occasionally during the working, as it is liable to become caked as the plaster sets upon it. When a whole length has thus been roughly

Fig. 6.—Templating a Base Moulding

run over, some filling in of crevices and scratches caused by lumps being dragged along the surface by the template will almost certainly need to be done, and the final surface is then given when the plaster has become set.

Given a clean-cut template, a base that nicely fits the guide-piece, and some experience, angles almost as sharp as a knife edge are possible.

Fig. 6 shows the templating of a base moulding of a pedestal, the actual surface of the pedestal, in this case, together with the ground, forming sufficient guides. It will be noticed that the pieces fixed to the top and bottom of the template prevent it from working other than in a straight line.

Templating Square Pedestals, Plinths, etc.—These are worked upon a baseboard, usually the same size as the bottom of the required pedestal. It can conveniently be made by mitreing

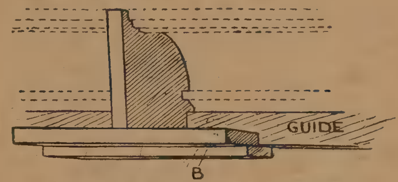


Fig. 4.—Templating a Cornice

four strips of wood together, about $2\frac{1}{2}$ in. wide by $\frac{3}{4}$ in. thick, to make up the required size (see Fig. 8). It is more economical to make a pedestal hollow, and therefore a rough core of damp clay is built up in the centre of this baseboard; the core can be very easily removed afterwards. Often a wooden core is used in the case of cement work. Cover the core with a surface of wet plaster or cement to the rough shape of the mouldings, and allow this to harden before laying the surface coat and templating. During the interval prepare the template, making especially sure of sharpness and accuracy in the zinc profile by truing with files. Needless to say, the production of a good shape in the profile and accurate workmanship are of paramount importance, and Fig. 7, which shows a

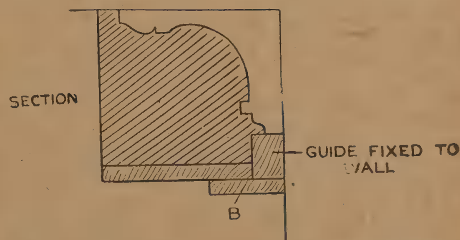


Fig. 5.—Section Showing Cornice Template

number of mouldings suitable for most purposes, will be of some assistance in the selection.

The template shown by Fig. 1 is seen actually in use in making a pedestal for a bust in the photographic illustration

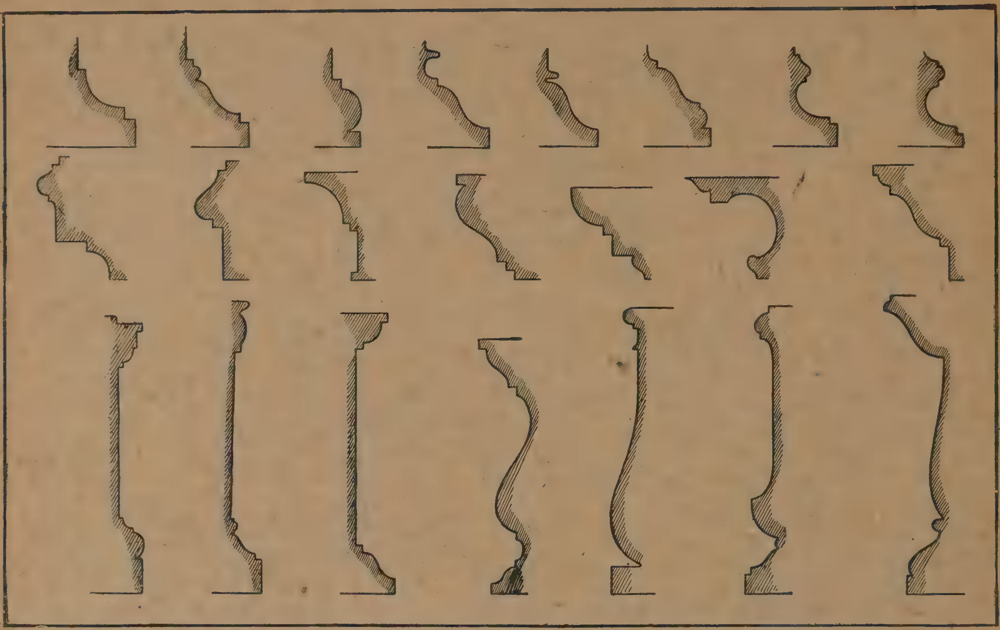


Fig. 7.—Sections of Mouldings for Various Purposes

Fig. 10. A slightly different form is shown in use in Fig. 11, where the "slipper" or base is substituted by a piece fixed at the back, the advantage being that it ensures that the template shall work perfectly vertically.

Templating Circular Shafts or Pedestals.—These do not present the difficulty that might at first be supposed, but a turntable will be requisite, such as shown in Fig. 9. It consists of two square boards, the upper one a little larger in size than the required pedestal. It has a circular hole in the centre that fits a wooden pin, such as a piece of broomhandle, that is let into the lower board, and forms a pivot for it to work upon. A generous application of black-lead between the two boards will materially assist their working easily.

For a hollow pedestal first build up a short core of plaster over four nails, fixed in the centre of the turntable, and embed in it laths all round, giving a cylindrical form, measuring in diameter an inch or so less than the narrowest portion of the required shaft. The template is cut from sheet zinc, mounted as previously described, and is strutted to the workbench in such a position that its ends at the top and bottom lie one-half the diameter of the shaft distant

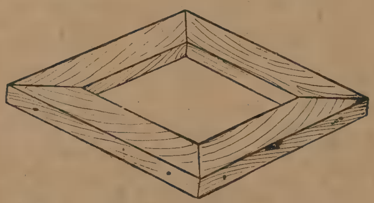


Fig. 8.—Baseboard for Pedestal

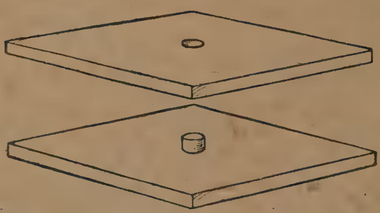


Fig. 9.—Turntable for Circular Pedestal

from the centre of the turntable. The template, it must be understood, is strutted to the bench, and is not fixed in any way to the turntable, which must be allowed perfectly free movement. The arrangement of template and core at this stage is shown in Fig. 12. Start now to build up the plaster or cement over the laths, up to the template, and obtain the forms of the moulding merely by revolving the table, which will cut the wet plaster to the requisite form. The success of the operation will depend mainly upon a well-strutted template that will remain perfectly rigid in use, and for this reason, two persons at the job are better than one, as one can steady, while the other lays on the material and revolves the turntop when the plaster is beginning to set. When completed, and the plaster or cement has set hard, the laths can be removed, the short core at the bottom knocked out, and small irregularities on the surface of the work either scraped off with a knife or filled in, according to their

Fig. 10.—Templating a Square Pedestal

nature. An old penknife, or a couple of plaster-workers' steel tools, will be found most useful for this operation.

Templating Circular and Curved Mouldings.—The template shown by Fig. 13 was employed for making a circular rim for a garden fountain. The zinc shape is firmly mounted and fixed to an arm, whose working length measures half the diameter of the required circle.

Fig. 11.—Templating a Square Pedestal

The end of the arm is held by a long nail, fixed in a block of wood in such a way that the nail forms a pivot for it to work upon. Fig. 14 shows the actual

Fig. 12.—Core and Template for Hollow Circular Pedestal

templating in progress. The rough work is built up upon a circle scribed of the required dimensions on the ground or working table, the template being worked away from the operator in forming the work. Semicircular arches and mouldings are formed by templates employed

similarly. In the case of small mouldings, the zinc only requires to be mounted on the end of a piece of wood, as in Fig. 15, and held by a stout nail.

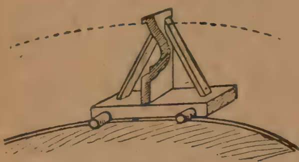


Fig. 16

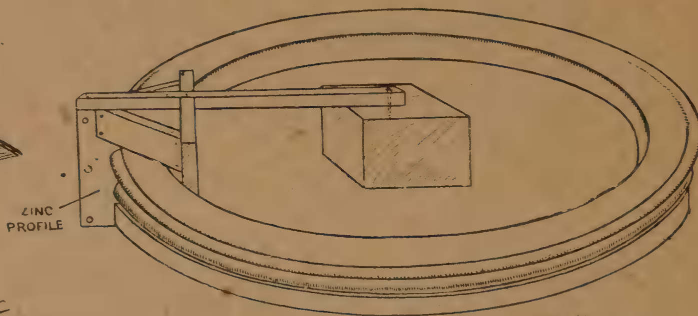


Fig. 14

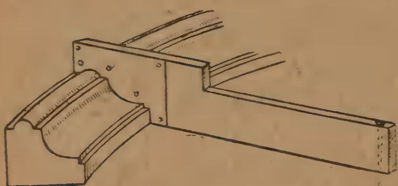


Fig. 15

Figs. 13 to 16.—Templates for Circular and Curved Mouldings

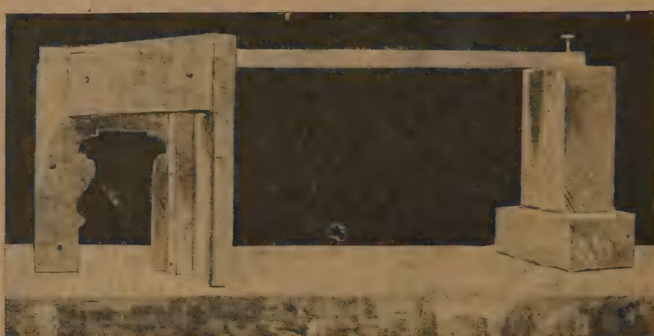


Fig. 13

Curved mouldings not of a circular form are run by means of what is known as a "pin mould" working along a guide-board. Arches, etc., can be quite easily worked in position, if preferred, the guideboard being cut to the required curve and securely strutted in position (see Fig. 16). The template is provided with two hardwood pins inserted in the front of the slipper; they move along the edge of the guide-board, and will be found to take almost any curve without jumping. The template shown by Fig. 1 will be found a most useful one for the work, and is, indeed, one that can be adapted to most purposes. The pins need only project about $\frac{5}{8}$ in., but the guideboard requires to be kept free from plaster or cement during the templating, so that they may move freely along it.

Restoring a Deal Chest of Drawers

THE chest of drawers shown by Fig. 1 has been originally a strongly built and useful article. It is of deal, stained and varnished in imitation of mahogany; but it has been in use probably over sixty years, and is now in shabby condition, though the carcase and drawers are still strong and rigid. Besides being much dented and scratched on the outside, all the dust boards and some of the drawer bearers and stops are missing from the inside of the carcase (see Fig. 2). The top has parted where it has been joined and must be taken off to be rejointed. It is found to be fixed with screws through the front top rail, and with nails to the top edges of the sides and back; it is necessary to knock up with the mallet, striking under the overhanging edge; but a rib of wood is placed against it to receive the blows, to avoid splitting.

The whole of the work is next thoroughly washed with soda and water, both inside and out, finishing off with pure water and leaving to dry.

The top is next rejointed; it is a simple "rubbed joint," and must be left to set. There are a few broken places which require piecing. Two of them are shown at A and B in Fig. 3. New pieces are dovetailed into these in the manner shown by Fig. 4, the pieces being left a little full to be trimmed level when glued

Fig. 1.—Chest of Drawers to be Repaired

in and set. One of the drawers has the beading broken (see Fig. 5). The best way to repair this is to let in a new bit of beading (see Fig. 6). In Fig. 7 these

Fig. 2.—Damaged Carcase of Chest of Drawers

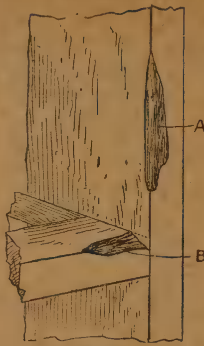


Fig. 3

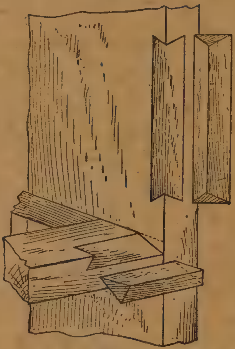


Fig. 4

Figs. 3 and 4.—Repairing Damaged Corner Edges

Figs. 5 and 6.—Repairing Broken Drawer Beading

Fig. 7.—The Finished Piecing Repairs

three bits of repair work are shown trimmed level.

New drawer bearers must be made to replace those that are missing, and also those that are badly worn. Worn bearers are quite a common trouble with old chests of drawers. In this case it is convenient to take them out and put in new ones, which is the best thing to do; use a couple of pins in addition to the glue, but they should be pulled out when set, or punched below the surface.

The new bearers are made as Fig. 9 shows; the groove is to take the dust board, and the end tongue fits the groove in the front bearer. They are glued into the trenched sides and secured with a couple of screws, as in Fig. 10. It will be

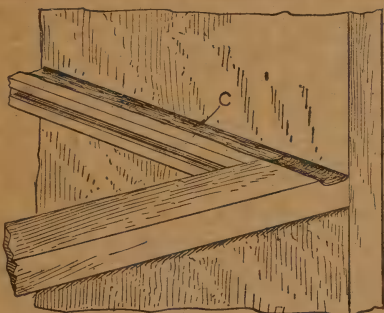


Fig. 8.—Worn Drawer Bearer

Fig. 9.—End of New Bearer

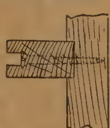


Fig. 10.—Fixed Bearer

Fig. 12.—Drawer Stop on Front Bearer

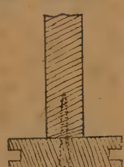


Fig. 11.—Centre Bearer Fixed to Division Piece

Fig. 13.—Finished Carcase of Chest of Drawers

but sometimes the old ones are put in reversed, the worn side down.

An example of a worn bearer is shown by Fig. 8 at C, which is a wide groove worn by the lower edge of the drawer side. In this condition they give much trouble, and cause worse damage, especially when they wear to about $\frac{1}{4}$ in. deep. When it is not convenient to take out the bearers, slips of wood are glued into the worn grooves. Sometimes it is necessary to necessary to put a centre bearer under the division of the two top drawers, fixed with screws. It must be 3 in. wide and grooved on both edges (see Fig. 11).

The dust boards are not absolutely essential, but it is better to have them in. It is usual to remove the carcase back to slide the thin boards into the grooves of the bearers. This one, however, happens to be nailed in very strongly, and would give considerable trouble to

take out and replace, so the two lower ones are put in the same as the top one, in two parts, with a centre bearer, which is kept in position by being nailed through the back; the boards, of course, are put into the grooves before it is pushed into exact position. The boards need not be wide enough to reach the back, but must be pulled forward to fit into the groove of the front bearers.

Fig. 14.—The Finished Chest of Drawers

It is decided to put a complete new set of drawer stops on the front bearers. These are pieces of wood 2 in. by $1\frac{1}{2}$ in. by $\frac{1}{4}$ in. A gauge mark is made for them the same distance on as the thickness of the drawer front and 2 in. or 3 in. from the corner. They should be glued in place a little forward on the gauge line, and immediately, before the glue has the least time to set, the drawer is put carefully and gently into its exact position, thus pushing the stops back correct. By the time the last drawer is put in the first stops will be about sufficiently set for the drawer to be removed to allow of the stops being fixed with a couple of fine brads (see Fig. 12).

The carcase is next scraped quite clean, free from all the old stain and varnish, and smoothed up with middle No. 2 glasspaper on a cork rubber. The corner edges of the sides, plinth and feet were rubbed down slightly round to remove the dented and chipped appearance; also the rails, etc.; but these latter only to take off the sharp squareness. The top was next cleaned up and replaced, also the drawers; and it is decided to put a half-round beading along the lower square edge of the sides and plinth as an improvement.

There is nothing in the staining and polishing that cannot be done by a worker of ordinary ability. The staining is done with sienna mixed in hot size or very thin glue to the consistency of paint. It may be put on with a brush; but is best rubbed in with a rag and stroked evenly off. It is as well to give it plenty of time to dry thoroughly, otherwise there is risk of the polishing turning out badly weeks after, even though it seemed to be successfully done, owing to the damp working through. A careful workman would leave it till the next day in a dry atmosphere. Then it is smoothed with glasspaper and rubbed over with linseed oil. The surplus is rubbed off with a clean rag, when it may be given a first "bodying in" of polish. To do this a piece of old calico print is required about 7 in. square, and inside of this is folded a piece of wadding. In shape it should be like an egg pointed at one end. About half a pint of ordinary brown french polish will be enough for the present purpose. Some of it is poured into the wadding so that, when the cover is stretched tightly over, a slight squeeze will cause it to ooze evenly through the surface.

The tip of the finger dipped in linseed oil should be rubbed over the surface of the "rubber" to make it work smoothly. It is then applied to the work, going over the whole surface in long strokes, and

Fig. 15.—Drawer Bottom Loose

then again with a circular motion, taking care to get well into the corners. More polish must be added to the "rubber" as it works out fairly dry, and the operation repeated until a slightly polished surface is obtained. It is now of a reddish colour, resembling some of the cheaper qualities of plain straight-grained mahogany. To improve on this, some of the polish (about half a cupful) is coloured by adding a pinch of bismarck and walnut aniline stain to gain the required shade. This is applied with a camel-hair brush, using a little judgment to imitate the light and dark streaks peculiar to some of the better qualities of mahogany. With a smaller brush some short marks are put across at various parts of the drawer fronts to imitate the shades sometimes called by furniture makers "fiddle back," because of its resemblance to the marks across the backs of the better kind of violins. Those who are not sufficiently well acquainted with these particulars should observe a piece of furniture made in real well "figured" mahogany.

About half a pint of "brown hard" spirit varnish is now required, and two or three coats are given, allowing about an hour or more between each, and smoothing with No. 0 glasspaper. Finally it is done over with a "rubber" of polish to level and harden it.

The whole process is best conducted in a warm room free from dust or draughts. During the first rubbing any defects that might be noticed should be filled up with coloured putty.

Instead of the pot knobs, turned wood mahogany ones with mother-of-pearl centres are put on. These are to be obtained ready made at some furnishing hardware stores.

The chest of drawers should have a good appearance when finished; but on pulling out the drawers the deal insides look somewhat disappointing; so they are best lined with blue paper neatly pasted in, which is a good old-fashioned practice. The outsides of the drawers are oiled over, especially the lower edges, also the inner sides of the carcase and the bearers. The linseed oil rubbed in gives the wood a better appearance, and keeps it clean; besides which it makes the drawers slide easily and prevents wear (see Figs. 13 and 14). Being rather a heavy piece of furniture when filled, a set of dome casters is put on the feet to enable it to glide about easily.

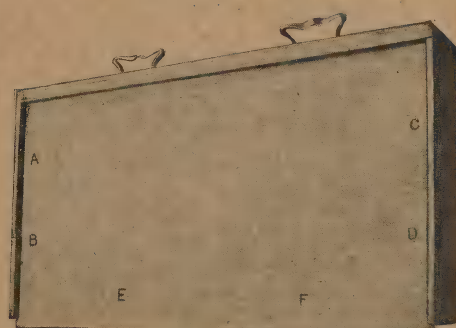


Fig. 16.—Drawer Bottom Secured with Glue and Pins

Securing Drawer Bottoms.—In cheap furniture the bottoms of drawers are frequently fixed in a perfunctory manner and soon work loose. It will usually be found that the bottom slides in grooves as shown by Fig. 15, in which it is seen

half withdrawn, and that it has either been glued in with untrustworthy glue or merely secured by a few small nails, which have dropped out. To effect a repair, the bottom is removed, all old glue being scraped off the edges and also out of the grooves. Some good fresh glue, not too thick, is then applied to the edges and the bottom is pushed home again. When the glue has set, one or two panel pins may be very cautiously inserted at the lower edges of the sides, as at A, B, C and D (Fig. 16). Two holes are bored at the back of the drawer, where there is no groove, as at E and F, and small screws are inserted. With such treatment, the bottom is unlikely to give further trouble. In some badly made furniture, drawer bottoms are only nailed on, so that the weight of the things inside sooner or later forces them off. In this case, glue is useless, except to keep out dust, but screws may be used to replace the nails.

Polishing and Mounting Horns

Horns—say those of an ox or buffalo—should first be well scraped with edges of broken glass until all the loose flakes are removed. Now give a thorough rubbing down with glasspaper, using coarse, medium, and fine, until the surface is quite smooth. Next apply vigorously, with a dry cloth, powdered pumice mixed with lard oil to a stiff paste, until the scratches entirely disappear and a dull polish begins to show. Then give several applications of putty powder (stannous oxide) and oil until a glassy polish is obtained, finishing with dry powder and finally the palm of the hand. This operation is a somewhat lengthy one, but success depends on the thoroughness with which each stage of the operation is performed.

To mount detached horns, proceed as follows: Cut two cores of wood to fit into the hollow ends of the horns, cutting the lower ends to give the correct carriage as in life. These two cores should now be securely fixed to a thin piece of connecting wood the same distance as they are apart in their natural positions on the skull. Mix some plaster-of-paris into a stiff paste, and cover the connecting wood, modelling it somewhat to the contour of the frontal bone. Finally, attach the horns to their respective cores with a couple of small wire nails driven through their bases and into the wood. Further model any deficiencies at their junction with the mount, and attach them thus to the polished shield with a pair of screws passing through. Where the connecting bone is present, cut it flat from behind with a tenon saw, and fix a piece of wood within the cavity thus afforded, securing it with a few nails passing through the bone, which should be subsequently painted white. This wood will afford a purchase to the screws securing the horns to the shield. To attach a skin in either of these cases, soak it in water until quite supple. Pare down the surface, stretch it across the forehead, and, drawing the edges over above and below, fix them with tacks driven into the wood.

The polished shield may be of ebony, mahogany, or ash, with a bevelled edge.

Renewing an Old Clock Dial

The dial of a clock is usually the first thing to get dirty or discoloured, especially if winding is done by opening a door in the front. Fig. 1 is a photograph of an old clock having a very dirty dial; while Fig. 2 illustrates the marked improvement effected by fixing a new dial, made in the manner to be described. First, take off the minute hand. Sometimes this is only sprung on and will come away by merely pulling at the centre, but generally it is secured by a small pin which is easily withdrawn. The removal of the hour-hand will then present no difficulty. The dial will most likely be fixed by screws to the case, or to the frame of the movement, and by unscrewing these it is detached. Place all the screws, the hands, etc., in a box or tray for safety while making the new dial.

Fig. 1.—Clock with Old Dial Needing Renewal

Fig. 2.—Clock with New Dial

There will be required a sheet of fairly

stout, smooth-surfaced Bristol board; a bottle of waterproof Indian ink; an ordinary and an ink compass; a pair of dividers and a ruling pen. Having pinned the white card to a drawing-board to prevent it shifting, measure carefully with the dividers the diameter of the outer circle of the dial, and with the compass make a similar circle on the card; next measure the inner circle, on which the graduations are to be inscribed, and transfer this also to the copy. The divisions may now be proceeded with.

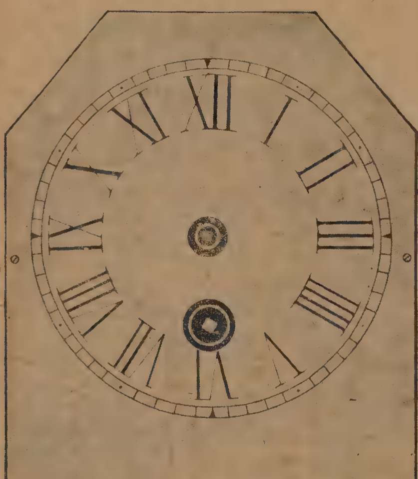


Fig. 3.—The Clock Dial Drawn on Bristol Board

Rule lightly a vertical line across the diameter of the circle; this will indicate the six o'clock and twelve o'clock graduations. A second line, also through the centre of the circle, at right angles to the first, divides the dial into four quarters. With the dividers, each quarter is then subdivided into three equal portions for the five-minute graduations, and each of the latter into five parts. The dial will then contain sixty divisions. Now measure the respective distances of the top and bottom of the hour figures from the centre of the dial, and with these distances as radii describe two more circles, thus obtaining guide-lines in which to write the figures. With the old dial as a copy, the hours may then be pencilled in, noticing that all the upright strokes radiate from the centre, while the short lines at the top or bottom of each figure are portions of the guide circles. Note that diametrically opposite figures are upside-down as regards each other, and that the "four" is drawn thus, IIII, and not IV.

When the whole is neatly inscribed in pencil, the inking over may be begun. The two outer circles are first done with the ink compass, then the divisions with the ruling pen, noting that each of these radiates from the centre. Every quarter-hour mark, however, is made thicker and wedge-shaped, while the intermediate five-minutes are indicated by dots. This will be understood by reference to Fig. 3, which is a larger photograph of the new dial shown in Fig. 2, taken before replacing the hands. The figures are next carefully inked in, first the radiating upright lines, then any cross strokes, and finally the curved lines at top and bottom, doing the latter with the ink compass. The thick strokes may conveniently be made by ruling two thin lines the correct distance apart and filling in the middle space with a fine brush or a ball-pointed pen. Care must be taken that one part is dry before attempting another. When all is dry, the pencil marks are removed with a rubber or stale bread, and the size of the dial is ascertained by laying the old one on top of it, marking at the same time the places where holes are required for the hands and winding key. These are cut out with the point of a sharp penknife, an inked circle having first been drawn round them for ornament. If all has been neatly done the new dial will be quite undistinguishable from an enamelled one, the pure white, smooth surface of the Bristol board having just the right appearance.

To fix the dial, the order adopted in removing the old one is reversed—that is to say, the dial is first screwed to the case, the hour-hand next placed in position, then the washer, and lastly the minute hand, not forgetting the pin, if one is used.

Stopped Drains and Burst Pipes

Testing Drains.—If there are leakages in drains, liquid matters will soak into the soil or sewer gas escape into the atmosphere, in either case to the infinite risk to the health of the occupants of the house. Drains are tested for leakages in various ways, not all of which are suitable for employment by the amateur.

The vapour test consists in pouring into the drain some essence of peppermint, essence of cloves, or other similar powerful scent, followed by a can or two of boiling water. Another test consists in placing in the drain crushed brimstone or sulphur wrapped in paper saturated with petroleum, and setting fire to it. In each case, the operator uses his nose to ascertain whether any of the scent or fumes can be detected elsewhere in the premises. The most reliable is the water test, but it needs to be carried out with extreme care. Plug the drain at the lower end, fill the drain with water up to some point where the water can be seen, and carefully mark the height of the water. If the water remains at the same level for several hours, the drain may be considered to be sound; but if the water sinks below the level, a leak will be found in the neighbourhood of wet earth. It is not thought that the amateur will often be in a position to carry out the water test properly, and he would do better to adopt the method of smoke-testing below described. A smoke machine is required. From it extends a piece of suction hose, tapered at each end. The free end is passed through the seal or trap of a gully, water-closet, or other sanitary arrangement, of sufficient dimensions in the bore to admit it. When the pressure is applied, it will drive out any water that may have collected in the hose; or the water seal of the trap may be broken and the hose inserted, the seal being made good again by pouring in sufficient water. The apparatus is also useful for locating the position of a disconnecting trap, where the grid or cover has been, through accident or ignorance, covered over with gravel, earth, or herbage.

Clearing Sanitary Pipes, etc.—The outlet pipes in connection with a washing trough in the scullery, or the wash basin and bath outlets in the bathroom, are liable at times to become clogged with soapy and greasy substances, thus greatly impeding the flow of water. A simple method of forcing and clearing them out is shown by Fig. 1 (next page), where a cork or bung is made to fit the place of the lift plug of the outlet pipe. In this cork is fitted a ½-in. pipe, then a piece of rubber tube of ½ in. diameter is forced over the pipe and tied with twine, and also forced and tied to the bib cock of the water company's tap above. It will be necessary to hold down the cork plug with one hand whilst the water is on, and if there is anything like a good pressure of water the pipe will be cleared in two or three minutes.

In cases where the grease is obstinate, use a flexible wire, six-strand steel for preference. Twist up one end like a cork-screw to fit the bore of the pipe easily, and work the wire through the pipe while the water is running. Another method is to pour boiling water in which is dissolved a fair proportion of washing soda. Plug the lower end of the pipe, and run in the hot water; as this cools let it out, plug up again, and repeat. The hot soda-water will dissolve the fatty matter and free the pipe.

Fig. 1.—Hose Connected to Water-tap for Flushing Basin Outlet

Fig. 3.—Bent Wire for Loosening Grease

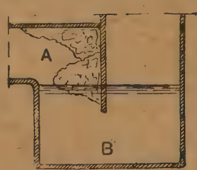
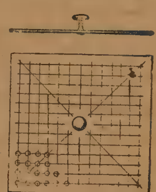


Fig. 2.—Section Through Water-sealed Trap



Figs. 4 and 5.—Metal Strainer for Grating

It not infrequently happens that an outlet pipe from a scullery trough leads into an ordinary water-sealed trap or sink outside the house, and in course of time the greasy deposit will gradually accumulate, and almost choke the outflow of the sink as shown at A (Fig. 2). Sometimes this can also be cleared by a bucket or so of boiling soda-water. A quantity of sand, dirt, and other foreign matter also accumulates at B in the bottom of the water seal, which must be scooped up with a piece of suitably shaped tin-plate. The grease at A may, however, require to be loosened by mechanical means, and for this purpose a piece of stout hard wire about $\frac{3}{16}$ in. in diameter, bent as shown in Fig. 3, will answer the purpose admirably.

Where previous trouble has been experienced with choking or clogging by foreign matter, such as tea leaves, vegetable and other refuse, it will pay to fit a portable strainer above the ordinary cast-iron grating. This may be in sheet iron or brass; the latter will last the longer. In this strainer drill a number of $\frac{3}{16}$-in. diameter holes fairly close together. The method of marking out and spacing the distance for the holes is shown by Fig. 4, while in Fig. 5 is shown a metal button riveted to the centre of the strainer for lifting up and brushing off the refuse matter into the sanitary bin or other receptacle.

Protecting Water-pipes from Frost.—Water-pipes burst when the water is in course of expanding into ice (from 39° to 32° F.), but, of course, the burst is not generally apparent until the thaw occurs. All exposed water-pipes should be protected. It may be said that popular ideas as to how a bad heat-conducting material protects pipes from frost are frequently wrong. Water absorbs and holds heat, but the heat is readily dissipated, or radiated, or becomes absorbed by cold air or substances with which it comes in contact, with the result that its temperature is reduced below 32° and the water becomes ice.

The purpose of a bad heat-conducting material is to form a barrier to this heat transference, so that should the water be, say, 50° F., the air and general surroundings can be much lower in temperature without reducing the heat of the water in any marked degree. The covering, therefore, does not afford any heat whatever, but prevents heat passing through it. Coverings, however, to be as effective as this, would require to be of materials which are perfect heat insulators—that is, perfect non-conductors of heat—but no such material is known, or, probably, ever will be known.

There are some very effective bad conductors, almost non-conductors, and the two best are undoubtedly hair felt and

silicate cotton (slag wool). Both vary in effectiveness according to the thickness of the covering. If hair felt is used it can be $\frac{1}{2}$ in., but $\frac{3}{4}$ in. is better for good work. It should be cut in strips and be wound on the pipes soundly; but it is best not to bind it on too tightly afterwards. It should be secure, but not compressed. The silicate cotton is usually a loose material, and requires to be placed in a casing. It can, however, be obtained sewn on to canvas.

Probably any one of the patent compositions used for jacketing steam boilers would answer the purpose excellently. The coating should afterwards be lagged with narrow boards secured with iron belts or bands, or be covered with canvas and painted, tarred, or otherwise protected from decay through damp or by atmospheric corrosion.

Stopping Burst Water-pipes.—The stopping up of a burst water-pipe temporarily till the plumber can arrive and effect a permanent repair is not difficult providing that one or two preliminaries are properly carried out. First of all, the water flowing through the burst pipe must be turned off; and, secondly, the pipe must be dried at the burst place, especially round the edges of the hole. With an iron or copper pipe, a blow-lamp or other source of direct heat can be used without fear of much damage, but with lead or composition piping the best thing to do is to heat an ordinary flat-iron to a temperature suitable for ordinary laundry work, and hold it against or rub it on the pipe, having first removed all superfluous water with a dry cloth. It is better to spend time to get the pipe dry, as really this is the most important part of the job.

Before, however, the drying is started upon, it is as well to prepare for making the cement, as the job will be found to take some time. Place one part of shellac in three parts of methylated spirit and stir it from time to time, till it becomes nearly as thick as paperhanger's paste. Cut off a fairly long piece of strong cloth, linen, or canvas, the latter preferred, and upon one end spread the cement with a spoon, sufficient of it being placed on the cloth to cover well the crack in the pipe. Place this over the aperture while the pipe is still warm, and press firmly and thoroughly into the opening, well filling it up, and then bind the cloth round the pipe in a neat and workmanlike manner, and secure it with string.

If a little more methylated spirit is poured into what is left of the cement to thin it, and this is well brushed over the cloth on the pipe, well soaking it in, and the whole is allowed to dry, as it soon will, before the water is again turned on, the repair will be complete and will last for quite a long time. Another cement that can be used in a similar way consists of five parts of gutta-percha, two of stockholm tar, and two of pitch; melt and thoroughly mix together.

Stopping Burst Soil-pipes.—Burst soil-pipes may be treated in the way above described providing that it is possible to dry them. Where drying is out of the question and there is but little pressure of water inside the pipe, a cement made as follows will be found to be effective: Take 2 oz. of resin and powder it to dust; then add to it one tablespoonful of plaster-of-paris and 3 oz. of linseed oil. Mix and apply quickly to the crack, pressing in well so as to form a key on the inside if possible. Make it smooth on the outside, and take a fairly long strip of cloth or canvas and over it spread some varnish, or the cement suggested for use in the case of water-pipes; bind this round the pipe, securing it with string, and finally varnishing or cementing the whole well over.

Do not allow anything to pass through the soil-pipe until the whole has had sufficient time to set, which it will do very quickly under favourable conditions.

Fitting Electric Bells

How the Bell Works. — Essential features of an electric bell are the electro-magnet and the dome, or bell. The ordinary electric bell is of the trembler type, and in this, when the magnet is energised by closing the circuit (in other words, when two soft iron cores are converted into a magnet by passing an electric current through the insulated wire with which they are wound), a soft iron armature carrying the bell hammer is magnetically attracted to the magnet poles (the ends of the cores), and in so doing the hammer strikes the bell. In order to obtain a regular repetition of this action, certain other parts are necessary. There is a spring that, when the bell is at rest, maintains the armature clear of the magnet, and this spring forms part of the electrical circuit through which current passes when the bell is required to ring. When the armature is attracted to the poles of the magnet the electrical circuit is broken, the magnet ceases to be a magnet (since it is energised only when current is passing), and the spring pulls the armature away from the poles and the hammer away from the bell. Instantly the circuit is again completed, the armature is once more attracted to the poles, and the little cycle of events described is gone through for the second time; and so on for the whole period during which the bell is ringing. Fig. 1 is a photographic view

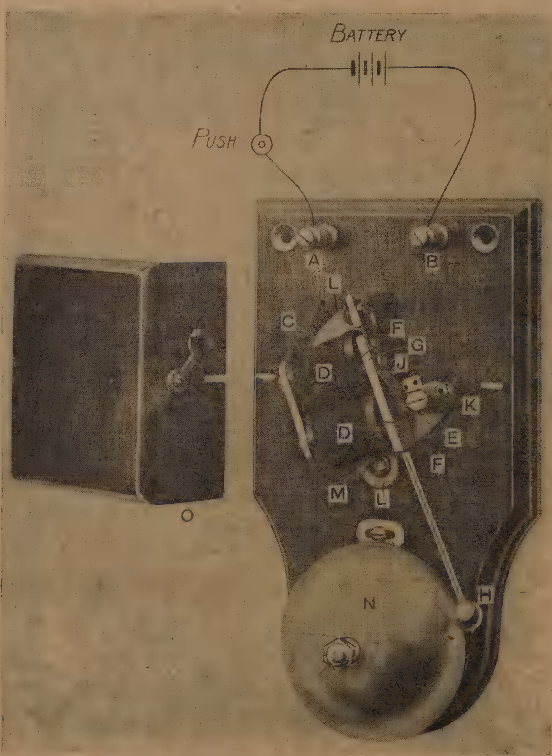


Fig. 1.—Electric Bell and Simple Circuit

which will make the foregoing quite clear, A and B being the terminals to which the two wires of the system are externally connected—A being internally connected (via spring C) to the winding of the electro-magnet D, and B to the metal back frame L; the poles of the magnets are situated at F F (hidden from view by the armature G). The armature has a hammer H and spring J. Contact is made and broken between the tip of the screw K and a speck of platinum attached to spring J. On a closed circuit, current flows from terminal

Fig. 2

Fig. 3

Fig. 6

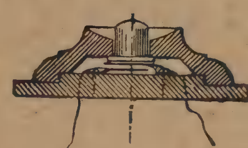


Fig. 4

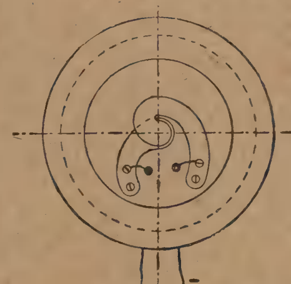


Fig. 5

Figs. 2 and 3.—Elevation and Plan of Push

Figs. 4 and 5. — Vertical Section and Internal Plan of Push

Fig. 6.—Brass Springs or Quadrants of Push

A, through spring C, magnet windings D, through an insulated wire (not in view) to the insulated pillar of E, through spring J, metal frame L, wire M (which runs at the back of the board) to terminal B, and thence back to the battery. N is the dome, gong, or actual bell, and O is the detachable cover or case.

The Push.—This device completes or breaks the circuit. It is obtainable in very many patterns, but Figs. 2 to 6, which show the ordinary kind, illustrate the principle of all. One wire is connected to one quadrant or spring plate, and one wire to the other quadrant; then, on pressing the push, the two plates make electrical contact, thus completing the circuit. The method of attaching the wire is shown in Fig. 10.

Preliminary Steps in Fitting Electric Bells.—This chapter will be devoted, not to the construction of the bell—a task it does not pay to attempt, since bells can be bought so cheaply—but to the work of wiring a house for, and fitting, the bells. It is often thought that electric bells, unless erected during the construction of a building, are unsightly and do not add in any way to the good appearance of the rooms through which the wires pass, and in which the various fittings are fixed. There are, however, many methods of concealing the wires and fittings in such a manner as to be entirely out of sight. These methods, of course, vary with the existing conditions both in the places and at the time of fitting. In this chapter various hints and suggestions for the benefit of amateurs desirous of installing electric bells are offered, as the result of experiment and practice.

The preliminary steps taken in the installation of bells are, as a rule: (1) measuring the length of the course on which the wires are to be laid so as to ascertain the amount of wire required, (2) the purchase of the necessary fittings.

such as bells, batteries, pushes, switches, etc., and (3) the selection of suitable positions to be occupied by the fittings.

Fig. 7.—Electric-bell Battery (Leclanché type), Complete and in Parts

Fig. 8.—Adjusting Hammer of Bell; this should be done while someone presses the push and closes the circuit

Fig. 9.—Adjusting the Bell; this should be done while the circuit is closed so as to tell by sound of bell when adjustment is correct

Fig. 10.—Attaching Wire to Spring of Push

The Wire.—In measuring for wire, do not omit the "corners" and recesses; they invariably lead the fitter to end up short of wire. Either twin wire or two single wires may be used; in one kind of twin wire there are two wires laid flat and both afterwards enclosed in one covering; this, when laid, has the appearance of a single wire, but should anything at a later date go wrong with the circuit, such as a breakage or shortage of the wires, it is a difficult job to locate the fault, both wires being under one covering; whereas in the case of ordinary twin wire, two wires of distinctly different colours are twisted

together, and the broken one can easily be traced by means of its own colour.

No doubt the best way is to run two separate wires throughout, and, if possible, each some distance away from the other, so as to facilitate the location of any faults in the circuit. The simpler way, though, and the one more often used, is to run both wires under one set of staples, and this method, if executed with care, will be quite satisfactory, particularly if two wires of a different colour be employed.

The Fittings.—The next thing is to select the fittings. These undoubtedly should be of the best; no cheap, inferior goods of any kind should be used, as they generally prove the most expensive in the end. Cheap bells of foreign manufacture, supplied with complete bell sets and usually sold at a low figure, frequently give a lot of trouble. A good English-made bell will respond to the feeble current given off by a battery of cells, or, if the circuit is only a short one, even from one Leclanché cell when the liquid extends only 2 in. or so up the side of the jar (this through evaporation); or, in the case of dry cells, when they are almost exhausted. But it may need some adjustment, as to which see Figs. 8 and 9. No word is here required as to the choice of pushes or switches, these being so numerous in assortment and so simple in construction that the choice should be made to meet individual requirements.

The Battery.—In ordinary circumstances, Leclanché cells are the best to employ on account of their cheapness, both initially and to recharge, and their unequalled performance in electric bell work in general. Leclanché cells (see Fig. 7) can be bought so cheaply that it would not be profitable to make them on a small scale. For use where the battery is exposed, dry cells may be used; they may be enclosed in a suitable box (see Fig. 11). For a distance of about 20 yards or 30 yards one cell will answer very well, although, of course, two would be better, and for greater distances additional cells may be added proportionately. There is a growing tendency to install dry cells in the place of the wet Leclanché cells.

Running the Wires.—All the fittings having been purchased, the following suggestions might be adopted with advantage in fitting up the bells: First decide on suitable positions for the bell, push or pushes, and, if desired, a switch. A one-way lever switch fitted behind the front door is a wise precaution in cottages. Children delight in ringing the bell during the absence of the householder. These fixed in their respective positions, the wiring can next be proceeded with. Begin at the push, leave a few inches over the correct length, and drive in the first staple. The staples should be driven in about every 1 ft. 6 in. or 2 ft., and great care should be taken both in this and in every other stage of wiring, for, however

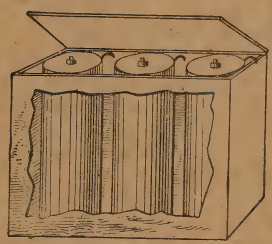


Fig. 11.—Dry Cells in Box or Case

good bells and fittings may be, if the wiring be at fault the system will constantly be "breaking down."

Where wires are laid underneath floorboards, for instance, a considerable amount of trouble would be entailed in taking up the boards, etc., to remedy the fault. A staple driven in too far may penetrate the covering of the wires and cause a short-circuit, and if not driven in far enough the wires are liable to sag and look unsightly. The writer has found the following to be a useful hint. At the position where each staple is to be driven in, wrap a short length of black adhesive tape round the wires, as shown in Fig. 12, and drive the staple home on top of this. The object of these lengths of tape is to enable the wires to be held securely in position without the staples penetrating the coverings. When turning a corner this method is a good protection against the sharp edges of skirting boards, etc., as Fig. 13 shows. On

reaching the positions to be occupied by the battery, cut one wire if two single ones are being laid, and if twin wire is used cut both of them, so as to avoid leaving a loop

Fig. 12

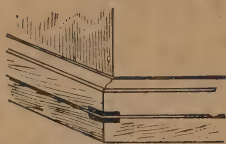


Fig. 13

Figs. 12 and 13.—Methods of Protecting Wire

afterwards in the wire not connected to the battery. After allowing 6 in. or 7 in. to spare, begin laying the wires once again. These two loose ends should be twisted round a lead pencil to form a spiral spring, which gives a neater appearance than if the ends are left hanging loose, and allows slight play should this afterwards be necessary. This is also off the covering for about 1 in. or 2 in. from each end, clean the wires, and twist them tightly together; and if it is desired to solder the joint afterwards, so much the better. All joints should be wrapped first with rubber tape, and finally with black adhesive tape.

Various Circuits.—The ordinary simple bell circuit, namely, one bell ringing from one push, is easily fitted up. The wires run direct from battery to bell, via the push. The accompanying diagrams show the general principle of various systems of wiring, and from these may be gathered how to fix bells for many purposes. Fig. 14 shows two bells wired in series, both to ring from the same push; in Fig. 15 two bells in different rooms are shown to work from the same battery. One bell can be wired to ring from various points as shown in Fig. 16. Where the bell can be fixed near to the gas bracket in a room, only one wire need be laid if so desired, as shown in Fig. 17. A is the gas bracket in one room, S the switch near

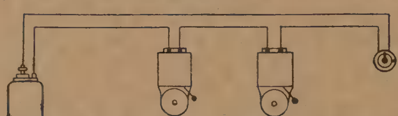


Fig. 14.—Two Bells to Ring from One Push

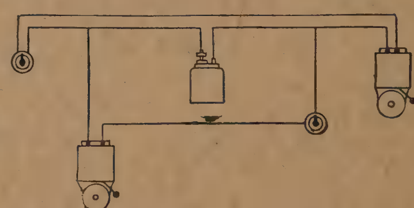


Fig. 15.—Circuit with Two Bells and Two Pushes

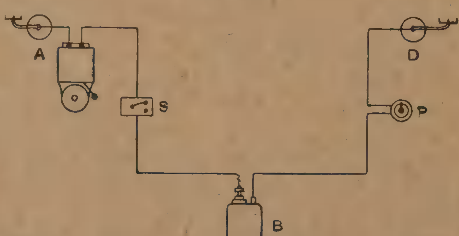


Fig. 17.—One-wire Method, Gas Piping Forming Part of Circuit

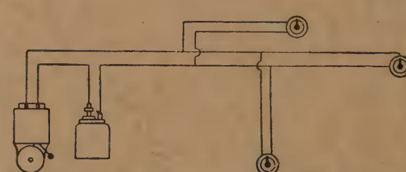


Fig. 16.—Bell to Ring from Three Pushes

done at the completion of the circuit where the wires are coupled to the bell. When it becomes necessary to make a joint, too much stress cannot be laid on making a good one; the bell fitter should not be content with half a job. Scrape by, B the battery, P the push in an adjoining room, and D the gas bracket in the same room. By this method the return from D to A is made through the lead piping, thereby only requiring one wire to be laid.

Faults.—Should anything appear to be wrong in the system, so that the bell will not ring, first test the battery to see if this is exhausted. If a voltmeter is not at hand, take down the bell and connect it direct up to the battery. If the battery gives off a current, and the bell does not respond to it, carefully adjust the contact screw on the bell until the best result is obtained.

Should both the bell and the battery work satisfactorily when connected direct to each other, but yet not when in their respective positions in the system, the wiring should be carefully examined to ascertain if there be any breakage or corrosion of the wire through dampness, etc. The poor contacts on cheap bells easily corrode and cause failure. Contacts should be made with a speck of platinum, but in very cheap bells a bit of solder is made to answer the purpose—with bad results after a time.

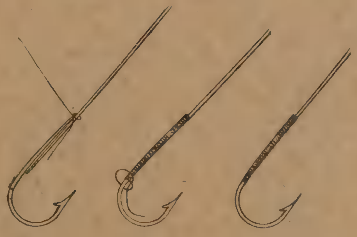
The following rules should be noted: Do not use cheap wire or fittings; good ones are the best. Good insulation and protection is wise at all times. Keep the battery clean, and remove all traces of "creeping"; the salts tend to creep over all the parts of a wet Leclanché cell. Clean, bright contacts will ensure better results.

Whipping Fish-hooks to Gut

Well wax a piece of binding silk, which can be obtained from any tackle dealer's; or a piece of fine sewing silk may be used. Cobbler's wax is best for the purpose; but the black is an objection if it is desired to show the colour of the binding; and transparent wax may be obtained from the dealer's for the purpose. Soak the end of the gut in warm water, or hold it in the mouth for a few seconds, and slightly roughen the end by chewing it. Lay the gut along the inside of the shank of the hook as shown at A, place the end of the binding on the gut, and begin wrapping at the top of the shank. The first turn of the binding is shown, and the wrapping must be carried evenly down the shank, keeping the coils close together but not crossing them, nearly to the bend of the hook, where it is finished off with a half hitch by passing the end of the binding through the last coil as shown at B. It is advisable to make a second half hitch below the first for greater security before snipping off the end. The illustration C shows the finished hook.

Now place the bound shank between two pieces of bone or hardwood, press gently, and roll it backwards and forwards a few times, which will have the effect of smoothing any unevenness, and will make the binding appear solid.

Next apply a thin coat of varnish with a camel-hair brush, and, when dry, apply a second coat. The varnish may be made by dissolving shellac in methylated spirit; or for a coloured varnish, crush a piece



Whipping Fish-hooks to Gut

of sealing-wax of the desired tint, and put a teaspoonful into a bottle with about two tablespoonfuls of methylated spirit. Put in a warm place, and shake occasionally until the wax is dissolved. If too thick add a little more spirit. For a transparent varnish use bleached shellac instead of the sealing-wax.

Glass Blowing and Working

THE methods of glass blowing "before the blow-pipe" can be mastered by anyone having a few appliances and sufficient patience.

THE MATERIAL

Glass is an interesting product in many ways, and one of its most important properties is that of becoming pasty or plastic between the temperatures of melting and solidification; hence, when heated to the proper degree, it can be worked in a variety of ways before it sets and becomes rigid. Glass, however, is not a simple substance. It consists of a double silicate of an alkali with some other basic oxide, but its composition may be made to vary between wide limits, and its properties modified more or less to suit particular purposes. Speaking in a broad sense, glass is a double silicate of soda and lime, potash and lime, or potash and lead, the three chief kinds of glass being:

Fig. 1.—Blow-pipe and Bellows

Window or Crown Glass.—This is a soda-lime glass, usually of a pale green or violet tint when seen in the mass, and it is easily fusible. The soft soda glass usually employed for glass blowing is of this kind, the soda being in large excess, but in ordinary window-glass and glass for boiler tubes, etc., the lime is in greater proportion, which renders it harder and more difficult to work. Bottle glass is an impure soda-lime glass containing iron and alumina, the former imparting more or less colour to it.

Bohemian Glass.—This is a potash-lime glass, less fusible than the above and not so easily attacked by chemicals, for which reason it is used in the manufacture of most chemical glassware.

Plate Glass.—This is a potash-lead glass, easily fusible, highly refractive, very heavy, and practically colourless. It is very brilliant when cut and polished, hence is largely used in the manufacture of polished plate and also for cut-glass ware. A special kind, known under the name of "paste," is employed in the manufacture of artificial gems.

Tubing is sometimes made from lead glass, and for special purposes is no

doubt very useful. It can be cut very easily and softens at a low temperature, but in the blow-pipe flame, especially a smoky one, it blackens or appears metallic owing to the reduction of metallic lead in the body of the glass.

Glass Tubing.—As before stated, this should be of soft soda glass and all of the one kind, a most important point. Good glass tube should be free from bubbles, knots, and parallel lines. When cut with a file and broken it should leave a straight edge, and when heated in the blow-pipe flame it should soften and become workable at a red heat and not crack or devitrify—that is, become covered with a loose white powder which renders it opaque.

It is a curious fact, but glass tubing does not "keep"—that is, it gradually changes, becoming more brittle and inclined to fly to pieces and devitrify on heating, and therefore after a time it becomes useless for blow-pipe work. For this reason, tubing should not be bought in large quantities. Many sizes are made, but for the purposes of the experiments described in this chapter only three sizes need be obtained, these being $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{1}{2}$ in. to $\frac{3}{4}$ in. bore or internal diameter respectively.

Assorted glass tubing and rod can be bought by weight from any dealer in chemical apparatus.

Glass Rod.—This should be of the same kind of glass as the tubing, and

Fig. 2.—Tools Used in Glass Blowing

Fig. 3.—Small Flame

Fig. 4.—Large Flame

Fig. 5.—Smoky Flame

Fig. 6.—Breaking Ordinary Glass Tube

only two sizes need be obtained, about $\frac{3}{16}$ in. and $\frac{1}{4}$ in. diameter.

APPLIANCES

Blow-pipe.—The most suitable blow-pipe is a moderate-sized gas blow-pipe with cocks on both gas and air supply. The one shown in Fig. 1 was made by the writer from a portion of a gas bracket and a few pieces of brass tubing; it serves the purpose equally as well as a bought one, and such a blow-pipe could be constructed by anyone. A benzoline blow-lamp might be used, but is not altogether satisfactory because there is no arrangement by which the flame or the air supply can be regulated.

Fig. 7.—Breaking Large Glass Tube

Bellows.—These should be double-acting, preferably of the Fletcher type (see Fig. 1), though a pair of double bellows similar to those used at a smith's forge, but smaller, might be attached to the blow-pipe table and arranged so that they could be worked with the foot, leaving the hands free to manipulate the glass.

Triangular Tool.—This is made of stout copper with rounded edges and is mounted in a handle (see Fig. 2). A small piece of beeswax for lubricating the copper tool from time to time will be necessary.

Charcoal Cones.—One or two pieces of compressed carbon sharpened into the form of cones will be required. Both these and the triangular tool are for opening out the mouths of tubes, thus strengthening them and putting on the finishing touch.

Rubber Tubing.—Two pieces of rubber tubing $\frac{3}{8}$ in. or $\frac{1}{2}$ in. internal diameter for gas and air supply respectively will be necessary.

Files.—One small triangular file for cutting tubing, and one small round, or rat-tail, file for smoothing the inside edges of tubes should be obtained. These should be of fine cut, clean, and new; and they should not be used for any other purpose, otherwise they will soon lose their cutting edges.

MANIPULATING THE BLOW-PIPE

Before proceeding to the actual work of glass blowing, it will be of advantage to study the blow-pipe flames a little and to learn to manipulate the blow-pipe. For this purpose turn on a little gas, light

Fig. 8.—Bending Tube in Flame

Fig. 9.—Bending Tube in Flame

up, and blow gently with the bellows; this will result in the production of a small pointed flame (Fig. 3) which is very hot and has powerful oxidising properties. It will be found useful when a local intense heat is required, as, for instance, in blowing a hole in a tube or in jointing tubes. It will be referred to shortly as the "small flame." Next turn on the gas full and blow with the utmost power, the result being a very large violet flame (Fig. 4), not so local or intense as the small flame, but more suitable for heating large objects. This may be termed the "large flame." Perhaps the best flame for ordinary work will be one intermediate between the small and the large, but this will depend upon the pressure of the gas and the size of the blow-pipe. If, now, the air supply is checked or cut off the result will be a large luminous flame (Fig. 5). This is a reducing flame, and, being much cooler than the others, it very quickly deposits soot upon any cold object placed in it. For this reason it is useful for cooling or annealing objects after heating in the hotter flames, the deposit of soot forming upon them when they are sufficiently cool serving as an additional protection to them when they are laid on the bench, and considerably reducing their liability to fracture.

Fig. 10.—Drawing Tube for Jet

CUTTING TUBING AND RODS

For cutting small glass tubing, make a clean file mark partly round the tube at the point to be severed, hold the tube firmly with both hands, placing a thumb on each side of the mark (Fig. 6), then press sharply downwards. If this is properly done the tube will break clean across. Glass rod may be cut in the same way, but large-sized tubes are more difficult to sever. Tubes of $\frac{1}{2}$ in. to $\frac{3}{4}$ in. diameter may be cut by making a file mark around the tube, holding, as before, with both hands, and striking the part to be severed smartly against the edge of the bench (Fig. 7). In many cases the tube will break clean across, but sometimes the operation is not successful, the break being irregular; in such cases the jagged portions may be broken off by using the wards—or rather the notches—of a key like a lever and the

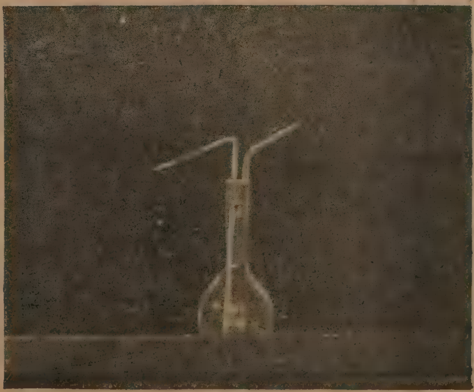


Fig. 11.—Wash Bottle

Fig. 12.—Bending Tube while Gently Blowing

cut made straight with a file. Large tube can be cut more successfully by applying a piece of glass rod, drawn out to a fine point and made red hot, to the file mark, and then allowing a drop of cold water to fall on the part thus heated. Usually the tube cracks at once, but, if it should not do so, a repetition of the operation will probably be successful.

BENDING GLASS TUBES

Glass tubes of small diameter are very easily bent in the ordinary "fish-tail" burner, as this allows a large surface of the tube to be heated. To make a bend in this way, take a piece of $\frac{1}{4}$-in. tubing 6 in. long, hold it in the flame of the burner near the tip, which is the hottest part, and rotate slowly between the

Fig. 13.—Bad and Good Bends on Tube

fingers. When the glass begins to soften, remove from the flame and gently bend it into the form shown by Fig. 8. Soften both ends in the small blow-pipe flame and lay aside on a wooden support to cool. Next take a piece of the same tubing 9 in. long and bend it in the same way into the form shown by Fig. 9. Now take a piece of the same tube, hold it in a horizontal position in the small blow-pipe flame (Fig. 10), rotating slowly but continuously until it is red hot, remove from the flame and gently draw away the right hand until the tube becomes a capillary about 2 in. long. Cut with a file and round off both the capillary and the larger end of the tube

Fig. 14.—Bending a Large Tube

with the small blow-pipe flame. If a flask is now obtained, also a rubber cork bored with two holes and a small piece of rubber tubing, there will be all that is required to make a wash bottle (Fig. 11), which will be found very useful either for chemical or photographic work.

It is rather more difficult to bend tubes in the blow-pipe flame; therefore, a little practice may be necessary. For this purpose, rotate the tube in the position shown by Fig. 10, using the large flame; when the tube is softened sufficiently, remove it from the flame, place a finger on one end of the tube, and, while bending, blow gently through the other end (Fig. 12). If the bend is to be an acute one it will be more satisfactory to have two or more heatings, bending only a

little each time. The object of the blowing is to prevent the glass falling in if heated too strongly. A good bend is shown at C, and bad bends at A and B (Fig. 13).

Tubes of ½-in. diameter must be bent in the blow-pipe flame, because the "fish-tail" burner is not sufficiently powerful to raise them to the desired temperature throughout. For this purpose take a piece of ½-in. tubing, hold it in an inclined position and then heat in the large flame of the blow-pipe; when sufficiently softened, draw out the tube with a rotary motion and seal off the end. Now heat the tube about 6 in. lower and again draw out, but instead of sealing the tube, sever it with a file. When the tube is cool, take it in both hands and heat the centre in the large flame (Fig. 14), rotating slowly; as soon as it becomes thoroughly softened, remove from the flame, blow through the open end, and, as the tube expands, draw gently, at the same time bend slowly into the form of the letter U (Fig. 15). This requires some little practice, as it is necessary to draw out the tube at such a rate that there is no real expansion. The tube is, of course, thinner at the bend, but this method of bending prevents the folding that would otherwise occur on the inside of the curvature.

Fig. 15.—U-tube

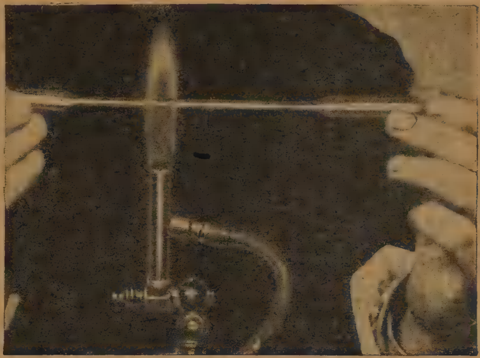


Fig. 16.—Drawing Tube Fine

DRAWING GLASS TUBE

It may now be of advantage to learn a little more about drawing tubes. For this purpose, take a piece of ¼-in. tubing about 6 in. long, hold it in the large flame, and rotate until red-hot; then remove and draw the hands apart quickly. This will give a longer and finer tube (see Fig. 16) than the one previously prepared. The length and diameter of the capillary tube will depend upon the temperature of the glass, the amount of surface heated, and the rate at which it is drawn, so that by varying these conditions, tubes of any thickness and diameter may be obtained.

Next take a piece of ½-in. tubing; hold it in the small flame, and when it becomes sufficiently heated draw slowly with a rotary motion; continue heating at the

Fig. 17.—Drawing Tube Coarse

Fig. 18.—Drawing Capillary Tube

thick part and draw the tube, little by little, until, finally, a tube of, say, 12 in. long is obtained (Fig. 17). In first attempts this tube will be very irregular, but with practice it will become more even, until finally an almost perfect tube will be the result.

Making Capillary Tube.—Take another piece of the $\frac{1}{2}$-in. tube and heat, this time in the large flame, as strongly as possible. As soon as the tube is at a bright-red heat, draw out very quickly to the full stretch of the right arm (Fig. 18). Cut off both ends with a file, and the result will be a long and extremely fine capillary tube of fairly even diameter except at the ends, which gradually widen out. By operating in this way the glass can be drawn out

Fig. 19.—Drawing Tube for Test Tube

almost as fine as a hair, and yet, however fine it may be, it is still a tube, as may be seen by placing one end in a tumbler of water and blowing through the other, when a stream of minute air bubbles will be found to rise through the water, or by standing one end in water that has been coloured, the liquid immediately rising in the tube by capillary attraction.

Sealing Tubes.—Test tubes are usually made from a very thin, light glass tubing made specially for the prupose, but practice can first be obtained with the ordinary kind. For this purpose take a piece of $\frac{1}{2}$-in. tubing about 12 in. long,

Fig. 20.—Removing Excess of Glass from Bottom of Test Tube

hold it in the large flame and rotate slowly. As soon as the glass becomes pasty, draw the hands apart with a rotary motion, endeavouring to keep the capillary tube as nearly as possible central. Heat the tube (Fig. 19) in the small flame and draw away the capillary; similarly draw away the capillary from the second tube, leaving two sealed tubes. Next take up one of these, heat at its point in the small flame, and with a short piece of glass rod applied several times draw away the knob of softened glass (Fig. 20). When this has been entirely removed, heat the closed end of the tube in the large flame until it is equably red-hot; then remove from the flame and blow

gently at the open end of the tube until the bottom is rounded, as in Fig. 21. Treat the second tube in the same manner.

A few words may be said about blowing. Hold the tube gently with the lips, not with the teeth, and blow gently at first, increasing the pressure as the tube cools. Always rotate the tube while blowing, and hold it either horizontally or in a slightly inclined position.

When the first tube has cooled, take it up again and hold the open end in the large flame in the position shown at Fig. 22; allow the glass to soften and fall in a little, then press into it one of the charcoal cones and rotate the tube against the cone so that a lip is formed (see Fig. 23). Cool in the smoky flame.

Smaller tubes may be rounded off in a similar way, but using a piece of stiff iron wire which is held at an angle while the heated mouth of the tube is rotated against it. Larger tubes are opened out with the triangular tool in the manner presently to be described.

Fig. 21.—Blowing End of Test Tube

Fig. 22.—Softening Mouth of Test Tube

Fig. 24.—Sealing a Tube

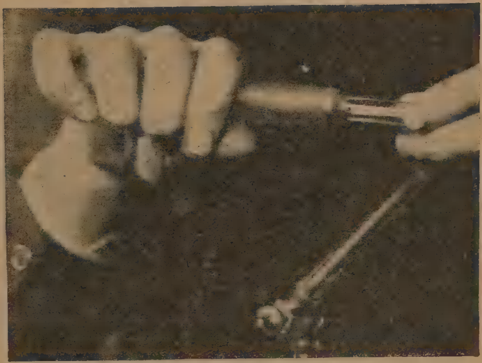


Fig. 23.—Opening Mouth of Test Tube

BLOWING BULBS

Blowing Bulb on End of Tube.—Take a piece of tubing $\frac{1}{4}$ in. diameter and 6 in. long, hold one end in the large flame and rotate slowly until the glass falls in and the end closes up entirely (Fig. 24). Continue heating a little

longer till the knob of glass thus formed becomes thoroughly red-hot, then remove from the flame and blow gently at the

Fig. 25.—Blowing Bulb on End of Tube

open end of the tube for a few seconds, holding it in a slightly inclined position and rotating slowly the whole time. If the operation is successful the result will be a small but strong bulb of $\frac{1}{2}$ in. to $\frac{3}{4}$ in.

Fig. 26.—Irregular Bulb

diameter, nearly if not quite spherical and evenly balanced on the tube (Fig. 25). This may not be obtained the first time; usually the blowing is too vigorous and the bulb is made so large and thin that it will not withstand a tap on the bench, or it may be even that the bulb is blown out into some nondescript monster like Fig. 26, which bursts with a loud report. This, however, will occur only in the first efforts, and a little practice will soon teach the right amount of blowing required.

Blowing Large Bulb.—For this exercise take a piece of $\frac{1}{4}$-in. tubing about 6 in. long, hold it as before in the blowpipe flame, and when the glass closes up blow a small bulb, as in the last example. Heat the tube a second time in the flame, but this time a little higher up than before, and blow a second small bulb similar to the first (Fig. 27).

Now hold the tube horizontally and heat both bulbs in the large flame, rotating rather more quickly as the glass softens to prevent the bulb falling to one side. The bulbs will gradually fall together to form one large oval or pear-shaped bulb (Fig. 28). As soon as this is fully red-hot, remove from the flame and gently blow a small bulb which should be spherical. Replace again in the flame and, after heating up, blow continuously until a large bulb of about

Fig. 27.—Blowing Large Bulb

$1\frac{1}{2}$ in. diameter is obtained (Fig. 29). The blowing should be gentle at first, but gradually increased in power as the glass cools, the rotation being kept up

the whole time. If successful, the bulb will be perfectly spherical and sufficiently strong to stand a blow from the knuckle.

Making Flasks.—The bulb thus made is really a small flask, and it is in this way that larger flasks are made from being acute and will thus be strengthened. This forms the bottom of the flask and allows it to be stood upright (Fig. 30). Cool in the smoky flame, allow to stand till quite cold, then wipe off the accumulation of soct. Sever the glass of the neck

Fig. 28.—Heating Bulb in Flame

Fig. 29.—Blowing Bulb on End of Tube

Fig. 30.—Forming Bottom of Flask

Fig. 31.—Pointed Rod

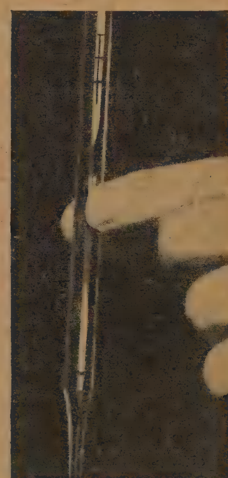


Fig. 32.—Tapering Rod

wider tubing, though they are, of course, much more difficult to blow. The flask may be finished by heating it on the rounded end with the large flame, which will cause the glass to fall in flat and even during rotation; while hot, blow out a little, then suck in quickly, this resulting in the glass falling in a little, but the edge will be rounded instead of with a file cut, heat the open end in the large flame, and round out with one of the charcoal cones (Fig. 23).

WORKING GLASS ROD

Glass rod will fly to pieces if suddenly heated in the blow-pipe flame, as it is much thicker than tubing; therefore it is necessary to heat it up more slowly

and to anneal it more carefully when cooling.

Stirring rods are made by cutting glass rod to a length of about 8 in. and heating both ends in the blow-pipe flame

Fig. 33.—Flattening End of Glass Rod

till they become rounded. For a pointed end, take a piece of the rod about 16 in. long, heat it in the centre and draw out in the same way as with glass tubing; then cut off the fine connecting piece and fuse both points (Fig. 31); the other ends of the two rods may be rounded. Instead of rounding off the ends, however, they may be made red-hot, and then flattened by pressing down on a smooth iron plate (Fig. 33). Remove quickly, or the sudden cooling will cause the end to crack off; anneal in the smoky flame. Rods for dropping purposes are made by drawing, but leaving a long tapering end (see Fig. 32).

Glass rod is bent and otherwise manipulated in exactly the same way as tubing, but it takes longer to heat up and requires slower cooling to prevent fracture.

BLOWING A GLASS JUG

The small flask made in a previous example may be used for this, or another may be made specially for the purpose. Heat one side of the neck with the small flame, and when it becomes red-hot, press the edge of the copper tool against it. This will produce a spout (Fig. 34). Now draw out a good length of glass rod fairly fine, cut off, allow to cool, and bend it in the form of the letter **S** (Fig. 35), flattening it, if necessary, while hot, on a smooth block of wood. Now take the flask in the left hand and the curled rod in the right and bring them together into the small flame; press first the upper loop then the lower one against the flask, and when the glass is just softened they will be found to adhere. This is a delicate operation, for which practice is necessary. Now anneal in the smoky flame and set aside to cool, wipe off the soot, and the result will be a miniature jug (Fig. 36). After a little practice it will be possible to make many variations of this shape, using opaque white and coloured glass tubing and rod. The little articles are a source of great delight to children.

BLOWING BULB ON CENTRE OF TUBE

Simple pipettes are made by drawing out a piece of glass tube in the centre (Fig. 10), severing with a file, and round-

Fig. 34.—Making Spout of Glass Jug

ing both ends in the flame for a few seconds. Bulb pipettes are made either with a spherical or an elongated bulb. The latter are comparatively easy to make, the size of tubing being chosen to suit the capacity of the pipette. It is simply drawn down in the flame at both

Fig. 35.—Fixing Handle on Glass Jug

Fig. 36.—Glass Jug Complete

Fig. 37.—Making a Pipette

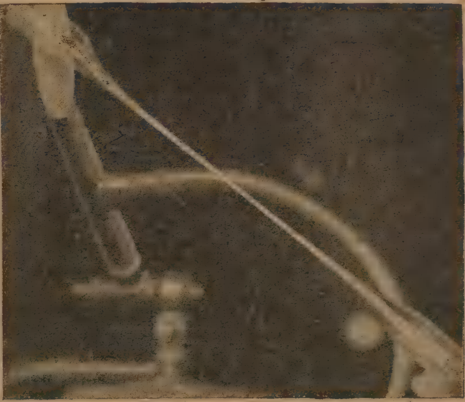


Fig. 38.—Drawing Wide Tubing

Fig. 39.—Drawing Large Tube for Bulb

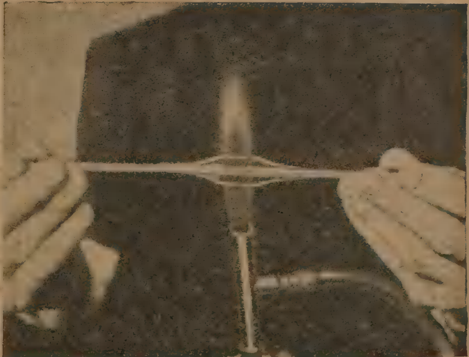


Fig. 40.—Holding Bulb in Flame

sides to form tubes of smaller diameter, one of which is drawn out to a fine point and the surplus afterwards removed with the file.

Bulb pipettes are made by blowing a

Fig. 41.—Blowing Bulb on Centre of Tube

spherical bulb on or near to the centre of the tube. This will need some practice, which may be obtained by using the $\frac{1}{2}$-in. tubing in the following manner: Hold a long piece of the tube in a sloping posi-

Fig. 43.—Blowing Thistle Funnel

tion against the bench and bring it into the large flame. Rotate slowly until the glass is sufficiently softened, then draw away the upper portion with a rotary motion, endeavouring to keep the drawn part as nearly concentric and straight as possible (Fig. 38). Allow to cool slightly, then heat the tube again about 1 in. below, and again draw out (Fig. 39). Heat the small tube and draw away. Allow to cool, and sever the end of one of the small tubes with a file. Now hold

Fig. 42.—Blowing Large Bulb on Centre of Tube

the tube in the right hand in a horizontal position, support it as shown (Fig. 40) by the fingers of the left hand, and rotate the tube with the thumb against the first three fingers of the right hand. Use the left hand simply as a support or bearing upon which to rotate it, and do not grip this end in the slightest. Now heat in the large flame, and when hot enough blow a small bulb (Fig. 41), again heat, and blow a large bulb of about $1\frac{1}{2}$ in. diameter (Fig. 42). If the bulb is blown properly it will be nearly uniform in thickness and evenly balanced, so that on rotating the tube there is no particular tendency to fall to any side. This will be somewhat difficult to attain at first, because usually the glass is thinner in parts and therefore tends to blow out more and become still thinner in the one direction, the bulb then being one-sided. With practice, however, this difficulty is overcome and a perfect bulb is the result. The bulb pipettes are made from smaller tube than $\frac{1}{2}$ in., and, in order to collect sufficient glass for a large bulb, two small bulbs are blown side by side, which are merged into one as in the formation of a bulb on end of tube. The position of the tube during blowing is slightly inclined, as in Fig. 42; it

should be rotated the whole time of blowing and should not be gripped in any way by the left hand, whilst the blowing should be mild at first, and gradually increased in strength as the bulb cools.

end of the bulb in the large flame, and spin it against the copper tool, which will open out the bulb and finish it off as shown (Fig. 44).

Large Thistle Funnel.—Prepare a piece of $\frac{1}{2}$-in. tubing similar to Fig. 39,


Fig. 44.—Opening Mouth of Thistle Funnel


Fig. 45.—Making Glass Pipe


Fig. 46.—Glass Pipe Complete


Fig. 47.—Making Large Thistle Head

BLOWING A THISTLE FUNNEL

Small Thistle Funnel.—Take a piece of $\frac{1}{4}$-in. tubing and blow upon the end of it a large bulb (Fig. 29). Heat the end of the bulb in the large flame, blow out a little (Fig. 43), heat again, and blow with sufficient force to burst the thin balloon which forms. Remove the fine glass and smooth the broken edge of the bulb with the round file. Heat the open

and blow on the centre of the tube a large bulb. Heat this at the junction of one of the fine tubes with the bulb, using the small flame, drawing away the tube as soon as the glass is sufficiently softened. similar to Fig. 47. Heat the end of the bulb with the large flame and blow out as shown in Fig. 43. Heat the tip of this elongation and blow out so as to burst it. Remove the thin glass and

Fig. 48.—Blowing Small Knob on Tube

Fig. 49.—Jointing Tubes at Right Angles

open out the thistle with the aid of the triangular tool as before. The thistle thus formed is severed near the head and fused on to a glass tube of about $\frac{1}{4}$ in. diameter, as described later.

BLOWING A GLASS PIPE

The glass pipe shown at Fig. 46 is a combination of the last two examples, therefore only the preliminary operations need be mentioned and a few other details. The pipe is made from $\frac{1}{2}$-in. tubing, which is drawn down first slightly for a moderate distance, leaving a bulb in the centre and one at the end next the capillary, the former being somewhat the longer of the two. Blow a large bulb on the centre of the tube and two small ones, one on each side (Fig. 45). Also blow a large bulb on the end of the tube, draw away the capillary, and convert the bulb into a thistle, which should be bent upwards ; curve the pipe as shown, making a mouthpiece by heating the end of the tube and giving it a slight nip with the warm pliers, which should be removed as quickly as they are applied so as to prevent the glass cracking. The finished pipe is shown at Fig. 46.

JOINING TUBES

Joining Tubes End to End.—Take two pieces of $\frac{1}{4}$-in. tubing, each about 4 in. long, blow a small bulb upon one end of

Fig. 50.—Rounding Off End of Tube

Fig. 51.—Jointing Tube at Side

each, as in Fig. 25, heat the end of each bulb separately in the blow-pipe and blow hard so as to burst the bulb. Remove the thin glass and fuse the open ends in the blow-pipe flame ; this will give an enlargement on each tube. Bring the tubes together as in Fig. 53, and heat in the small flame ; rotate and blow gently in at one tube, keeping a finger on the open end of the other until the joint fuses up (Fig. 54) ; then heat the whole junction and draw down slowly to the normal size. This is the only way in which a perfect junction can be obtained ; if the tubes were brought together without first enlarging, the result would be anything but perfect, besides which the joint, being much thicker than the other parts of the tube, would be almost certain to give way.

Fig. 52.—Jointing Narrow to Wide Tube

Making Joint on Centre of Tube.—To do this properly, take a piece of tube similar to the last, but about 12 in. long, draw out in the middle, and seal off, leaving two tubes. Take one of these tubes, heat in the small flame, and blow briskly so as to raise a small knob on the tube (Fig. 48). Heat the end of this knob, and blow hard so as to burst it, remove the fine glass, and fuse the opening in the small flame (Fig. 49). Now break the capillary tube of the second tube and blow a small bulb on the tube, as in Fig. 25 ; burst this bulb, as in the last example, and round off the open end (Fig. 50). Seal off the capillary again. Next bring the two tubes together in the small flame and turn about till the joint seals up, blowing very gently to prevent the glass falling in. The finished joint is shown at Fig. 51, while at Fig. 52 is shown a small tube joined to a wider one.

Fig. 53.—Jointing Tubes on End

The number of these examples might be multiplied indefinitely, but perhaps sufficient have been given to serve as a beginning. Those who become expert will soon devise examples for themselves,

Fig. 54.—Jointing Tubes on End

Fig. 55.—Vase Made from Tumbler

as there are many little ornamental things that can be made with coloured tubes and rods. Difficulties will, no doubt, be met with, but the best way to overcome these is to try again and again until practice does make perfect. There is a great charm in being able to handle glass properly, besides which the hobby may be made remunerative after a time; without this incentive, however, the pleasure derived from the work will amply repay for the time and patience spent upon it.

SOME USEFUL GLASS ORNAMENTS

Although purely amateur glass working by means of heat is necessarily rather restricted in scope, it is yet capable of producing a number of ornamental and distinctly useful articles, quite apart from the scientific apparatus and toys to which, so far, attention has been exclusively devoted. Using as a base a very thin glass vessel, bought ready-made, the possibilities of amateur glass working are vastly increased. For example, Figs. 55 to 58 show four vases which any amateur with a little patience could produce without special apparatus. They are formed from ordinary thin glass tumblers—the thinnest obtainable, the thicker ones being unsuitable on account of the large amount of heat required for softening, and their liability to fracture. The necessary equipment for such work comprises a gas blow-pipe (see p. 148) or, instead, simply an ordinary bunsen burner (Fig. 59), connected by rubber tubing to a gas supply; or any similar type of burner that gives a blue heating flame may be used. In addition to the bunsen burner, a brass mouth blow-pipe A (Fig. 60) is necessary, a pair of pliers B (with long pointed ends, for preference), a small file, and a copper former, this latter being merely a piece of fairly stout copper cut to triangular shape (as illustrated in the early pages of this chapter), and set in a wooden handle for convenience in using. For the material, obtain a few lengths of glass tubing, of which $\frac{1}{4}$ in. is a useful thickness, though it is best to have a variety handy for different purposes. The cheap bazaars will supply all that is necessary in the way of thin tumblers, etc.—the cheaper the better, for they are likely to be of softer

Fig. 56.—Vase Made from Tumbler

glass. The worker should have a pair of old gloves to protect his hands from burns during working.

For a start a beginner would be wise to make a few experiments in bending up tubing, so as to obtain a little insight into the peculiarities of the material. A, B, and C (Fig. 61) are simple forms of bends which are easily executed with the aid of instructions already given in this chapter. The twist D is easy to make; but be careful to heat only a short length of rod at a time, taking pains to heat an approximately equal amount each time, so as to get the twists even.

Fig. 62 shows the three preliminary stages in making a spiral, the end being gripped with a pair of fine pliers—a small space being left in the centre, or the glass will be wound close up. Fig. 63 shows sealed tube ends.

Fig. 55 has four deep indentations in the body of the glass about the middle, above which, on the edge, are attached four projecting portions of bent tubing that are twisted a short distance up from their union with the edge. The indentations are quite simple to make, the two processes being shown in Figs. 64 and 65. The flame of the bunsen burner is directed by means of a mouth blow-pipe to the glass, to soften a small area where the glass is required to be worked. When it glows and gives a yellow flame, drop the blow-pipe and press the pointed copper former into the glass, giving it a turn as it comes in contact with it, which will result in a deep indentation if the glass is sufficiently soft. This operation has to be done most expeditiously, as the glass very quickly loses its pasty condition when the flame is removed; indeed, it is best, if possible, to work the glass whilst actually in the flame, holding the blow-pipe by means of the lips. The

Fig. 57.—Vase Made from Tumbler

Fig. 58.—Vase Made from Tumbler

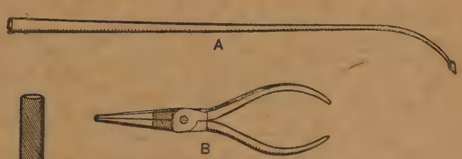


Fig. 60.—Blow-pipe and Pliers

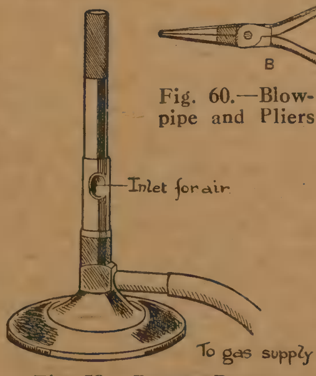


Fig. 59.—Bunsen Burner

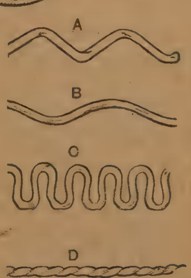


Fig. 61.—Bent and Twisted Tubing

process is repeated in four places, as shown in the illustration.

A very important point in glass working is the necessity for cooling gradually after each manipulation, as, owing to the unequal contraction of the material, it is liable to fracture unless due precaution is taken. Cooling must be gradual; the glass must be taken very slowly from the heat of the flame, and a good plan is to have a lighted candle at hand and hold the work above this so that the area all round the heated part becomes smoked, which will prevent very rapid contraction.

The uniting of the projecting parts

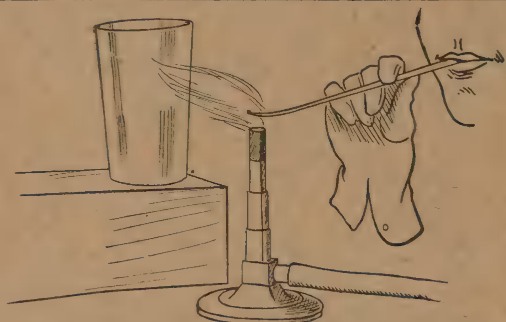


Fig. 64.—Blowing the Flame on the Tumbler

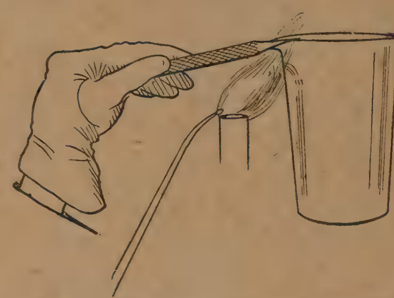


Fig. 67.—Forming a Frilled Edge on the Tumbler

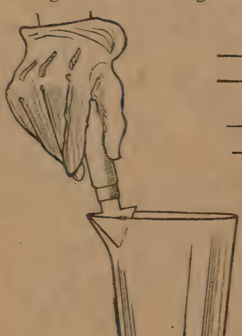


Fig. 68.—Finishing the Lip

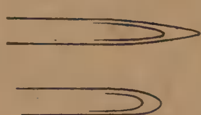


Fig. 63.—Sealed Ends of Tubes

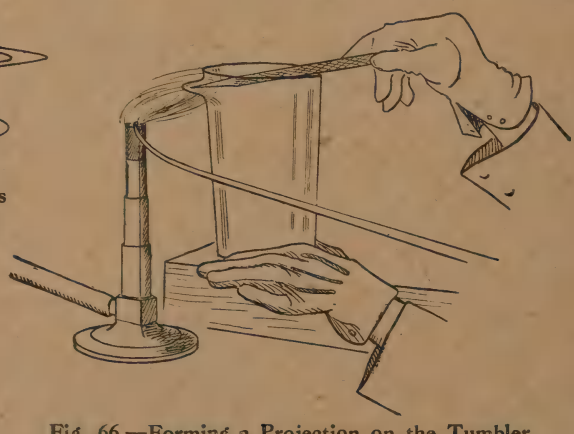


Fig. 66.—Forming a Projection on the Tumbler

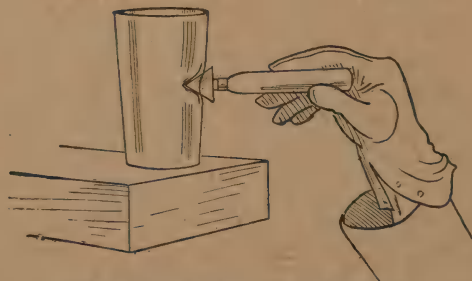


Fig. 65.—Making an Indentation

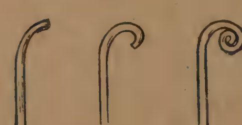


Fig. 62.—Making a Spiral

needs no further explanation after what has been said, but it should be seen that the two portions to be joined are well fused before being brought together.

The projecting portions in the upper surface of the glass shown by Fig. 56 are produced by pressing the tang end of a file from inside, as shown in Fig. 66, instead of from outside, as in the previous example. The handle is of twisted tubing, which is attached to two of the projections. The curved form of this can be best produced during the actual formation of the twists, a slight bend being made after each twist, the general shape being rectified at the finish, so that the two ends exactly meet the points to which they are to be attached.

The frilled edge in the example shown by Fig. 57 is produced by heating a small area of the rim at a time, and pressing the file down horizontally upon it when softened (see Fig. 67). The projecting portions are produced differently from those in the foregoing example, a length of closed-up tube being united with the glass in the required positions and then heated near the junction and drawn away, leaving a short portion attached. Some little patience will be necessary in the bending up of the handles, to get them quite alike in form. In attaching the handles to the body of the glass, the chief care is to see that the portion to be united and the body are equally heated and sufficiently fused to obtain a good junction.

Fig. 58 is another example worked on similar lines, the edge of the softened glass being worked outwards with the file end or copper former (see Fig. 68). The making of the spiral forms, added just below the projections of the rim, has already been described.

An Anti-freezing Solution

There occur many instances when a specially convenient purpose can be served if water can be prevented from freezing. Sometimes the water of a small heating apparatus or the water seal of an acetylene gas-holder requires to be protected in this way, and all that has to be done is to add calcium chloride in a proper proportion, this material (which looks like washing soda) readily melting in cold water.

Unfortunately, it comes rather expensive for large hot-water installations; otherwise it would be used for those in places of worship, or wherever the apparatus may be left out of use and cold in winter weather. It is used in the small-bore, high-pressure (hot-water) heating installations, as these do not hold very much water, and there is no loss, the apparatus being sealed.

The percentage is that of weight, so that each 10 gall. of water (which weighs

To prevent water freezing when at	*Add this percentage of Calcium Chloride*
22° F.	10
18° F.	12
15° F.	14
10° F.	16

100 lb.) will require 10, 12, 14, or 16 lb. of the chemical material, according to the low temperature to be resisted as shown. The temperatures given are those of the thermometer scale, the upper one being 10° below ordinary freezing point, low enough for the most severe indoor requirement. For outdoor gas-holders, the 12-per cent. solution might be necessary.

It requires to be added that calcium chloride may be termed chloride of lime, but this is not the same as, or anything like, bleaching powder, which is also called chloride of lime. Bleaching powder is lime subjected to the action of chlorine gas, and should be called chlorinated lime.

Door Bolts, Hinges and Other Fittings

Bolts.—In addition to the locks and latches of doors, bolts are necessary to give full security; and it is just as well to have the right thing in the right place and to have it in proper working order. For outside purposes, the galvanised-iron bolts are preferable to japanned-iron ones, as being less likely to rust.

For a yard door fitted only with a thumb latch, a 10-in. bolt, put on under the second batten, is recommended; and when the door is flush with the post, it is only a matter of fixing it on straight, as in Fig. 1; but if it is a newly hung door, the catch should be put about $\frac{1}{8}$ in. lower than the bolt to allow for the door drooping.

In many cases it is necessary to sink the catch into the post about $\frac{3}{4}$ in., and the average workman saws and chisels the piece out of the post. A much easier and quicker way, besides being neater and stronger, is to reverse the catch, it being let in simply by boring a hole with the $\frac{3}{4}$-in. centre-bit and chiselling out the thin side (see Fig. 2).

The japanned bolts are commonly used for inside doors; when appearance has to be considered, brass bolts are used, these being smaller and neater, and often necessitating the use of a plate-catch. When a bolt does not shoot into the catch, it should not be altered without first seeing that the hinges are right.

The screws with which hinges are fixed often work loose, and can only be tightened by plugging the holes before re-inserting the screws; but the ordinary cast-iron butt hinges used on inside house doors seldom require anything else but a touch of oil when they start to creak. When a door has to be taken down it is sometimes difficult to remove the screws. The recognised way to start a screw is to strike it with a hammer to loosen it; but this must not be done with a cast-iron hinge, or it will break. The best way is to clean the paint well out of the niche in the screw-head. The screwdriver used should be a powerful one, and the point should well fit the screw-head; or a turn-screw bit in the brace may be used. If it is still necessary to strike the screw-head the butt end of the turn-screw may be struck whilst in position. With perseverance any undamaged screw can be turned by these means.

Door and Gate Hinges.—Outside doors are usually hung with band and gudgeon hinges, and can be lifted off without the aid of tools; but they can be made not to lift off by putting the top gudgeon upside down, though this puts the weight chiefly on the lower hinge. These hinges are to be had in many sizes, some being extra strong for swinging heavy gates. The usual size for an average yard door is about 10 in. They should be kept well painted and oiled occasionally, otherwise they rust and wear, causing the door to droop till it scrapes the ground, besides putting the

latches or bolts out of use. A simple remedy for this, however, is to lift the door off and place a sufficient number of iron washers on the gudgeon pins to raise the door to its right position (see Fig. 3).

For inside doors of this class, T-hinges are more suitable, and they are also used for light outside doors, or any doors made with matchboarding (see Fig. 4). They shown by Fig. 6, and slides up it into its place. It should not be allowed to get rusty, and should be oiled occasionally. A little oil on the end of the latch and the catch will make it work with ease.

Door Hooks, etc.—The banging of doors is another annoyance which may be easily remedied. The crude way is to hold the door open by means of a weight

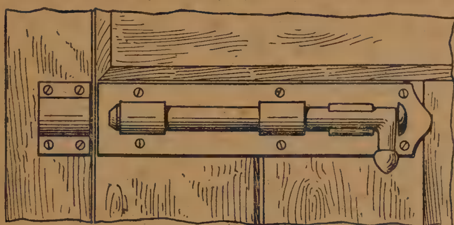


Fig. 1.—Door Bolt Correctly Fitted

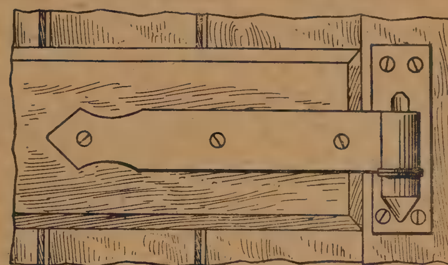


Fig. 3.—Band and Gudgeon Hinge, with Washers to Raise Door

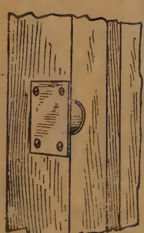


Fig. 2.—Reversed Catch

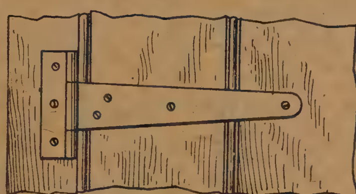


Fig. 4.—T-hinge

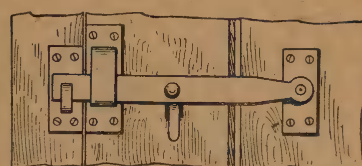


Fig. 5.—Thumb Latch

Fig. 6.—Relative Positions of Latch and Catch

Fig. 7.—Hook and Eye

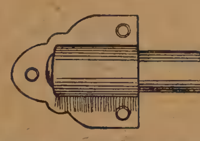


Fig. 8.—Door Silencer

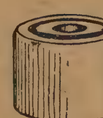


Fig. 9.—Door Stop

are very useful for many purposes, may be obtained in many sizes, are cheap, and are easy to fix.

Latches.—The common thumb latch is frequently put on in a very indifferent manner, regardless of appearance or utility; yet it is no more trouble to put it on properly, when it will look better, work more easily, and last longer. It is quite a common thing for the latch to get bent or knocked off through repeatedly banging against the point of the catch; but when it is put on correctly, as shown by Fig. 5, the latch strikes the catch as

on the floor at the corner of the door, but this in itself is a nuisance. There is a hook and eye for the purpose (see Fig. 7), which may be screwed at a convenient place on the door and the dado rail (if there is one), or on the skirting board. Such a hook can be screwed direct to a brick wall or plastered wall if the wall has been properly plugged for the purpose, and experience shows that the Rawlplug is the quickest and neatest and also the strongest method of plugging available. A small hole is made in the wall by means of a star-pointed jumper

or chisel, used with a hammer, a jute sleeve inserted and the wood screw driven in with a screwdriver in the ordinary way. No. 8 or No. 10 screws answer ordinary requirements, and the Rawlplug chisel and jute bushes or sleeves must be of a size to correspond.

There are also door silencers (see Fig. 8) to be screwed on the door post, with the rubber end about $\frac{1}{8}$ in. past the rebate to receive the concussion of the door.

When a door, on being opened wide, is apt to strike the wall or a piece of furniture, a rubber stop (see Fig. 9) should be screwed on the floor, behind, about 6 in. from the wall, or where convenient.

How to Fix Door Hinges.—It is common practice for hinges to be let in so that their centres come to the centre of the joint of the door (see Figs. 10 and 11) as otherwise, when the door is left slightly open, anyone outside can peep through the crack and see all over the room. But by adopting this method the joint of the door comes so close that it will not open much more than square before it binds on the mouldings, being then badly wrenched. It is therefore preferable to keep the top hinge out nearly $\frac{1}{4}$ in., and the bottom one $\frac{1}{8}$ in. more. Set out the hinges on the stile as shown at Fig. 12, the lines A and B being made with a marking gauge. Saw, pare out with a chisel, and then screw the flange of the hinge butt in position as shown by Fig. 13, its surface being just flush with the edge of the door. Next fix the door in position, pushing a wedge underneath until a joint about the thickness of a penny is obtained at each side and at the top. Mark the position of the hinges both at top and bottom with a chisel; then mark the thickness of the knuckle on the edge of the jamb (see Fig. 14), thus giving the depth to which to let in the hinge. The other edge of the hinge should not be let in more than its own thickness.

Fig. 10

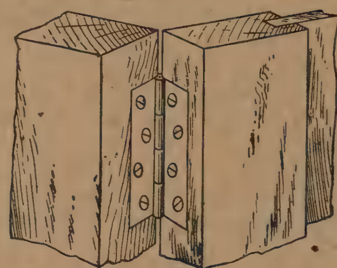


Fig. 11

Figs. 10 and 11.—Hinge Centre at Centre of Joint Between Door and Frame

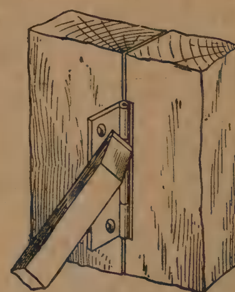


Fig. 14.—Marking Thickness of Hinge Knuckle on Door Jamb

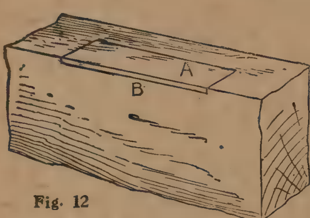


Fig. 12

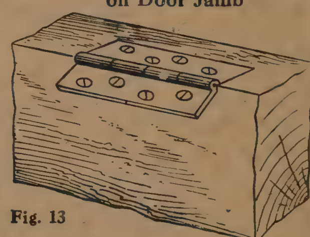


Fig. 13

Fig. 12.—Door Stile Set Out for Hinge

Fig. 13.—Flange of Hinge Screwed to Door Stile

Cheap Covers or Cases for Old Clocks

Simple Wooden Case or Cover for Clock.—An old clock with a worn or ugly case may be given a completely new appearance by providing an artistic cover from $\frac{1}{4}$-in. fretwood. Having first ascertained the necessary dimensions and the exact height and diameter of the circular opening behind which the dial will come,

Figs. 1 and 2.—Two Views of Cover for Old Clock

to fit over it. An advantage of this method is that the clock itself is not interfered with. One very convenient pattern consists only of a front, top and two sides. Fig. 1 shows a front view, and Fig. 2 a back view of such a cover, made the opening is cut with a fretsaw. A simple design is cut in the same manner, behind which are fixed pieces of repoussé decoration in copper or bronze, as shown by Fig. 1, though mother-of-pearl or even a darker wood offers an effective alterna-

tive. The four parts are fixed together with small french nails, but glue may be used if preferred. A narrow strip is finally glued at A to give the effect of a

Fig. 3.—Biscuit Box Cut Out Back and Front

bottom. To wind the clock, assuming it winds from the front, the cover is merely lifted off and replaced when finished.

Another method is to make the case with a top and four sides, but without a bottom; this keeps out dust better.

Cheap Metal Case for Clock.—An American clock that has lost its legs may be retained in service by inserting it in an ornamental case.

There are hundreds of ways in which this may be done, but in that to be described a decorative biscuit box, made of stamped sheet-metal, is utilised. Having decided on the position of the dial, an indentation is made where the centre of the circle will come by tapping the spot with the point of a nail. Then, resting one leg of a pair of dividers in the indentation, a circle a shade smaller than the diameter of the clock is scratched on the metal. The large blade of a sharp penknife is next pressed through at any part on the circumference of the circle, when it will be easy to complete the cutting-out of the latter, moving the knife partly with a sawing motion and partly like a tin-opener. Having done this, a smooth cylindrical steel bar—a small poker will do—is placed inside the opening and rubbed round and round against the edge, to bevel it down. A larger hole, about $3\frac{1}{2}$ in. in diameter, is now made in a similar manner at the back of the box for the insertion of the hand when winding up the clock (see Fig. 3); the edge of this also should be rounded. A block or platform of wood with a semicircular piece cut out of the top is next required to support the clock inside the case. This must be shaped to fit the box, trying the clock in position till it suits, and is then tightly fixed by means of wooden wedges. Lastly, the clock is inserted, the front being

Fig 4.—Biscuit Box as Clock-case

allowed to protrude about $\frac{1}{8}$ in. from the opening in the box, and is secured by screwing a wooden crosspiece over the top of the block, or in any other suitable way. Fig. 4 illustrates the clock in case complete.

Emery Discs, Bobs, and Wheels

THE amateur metal-worker's knowledge concerning the use of emery or its advantages as an economical substitute for the file as a cutting medium is not nearly so widespread as it should be. Every metal-worker knows how ruinous it is to put a new file straight on either forgings or castings in order to remove the hard chilled scale found on the surface of both. Often quite 50 per cent. of a file's value as a cutting medium is taken from it with the first dozen strokes across the face of a forging or casting.

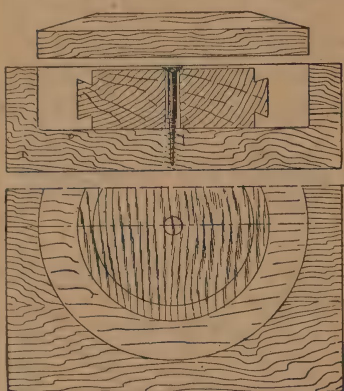
This chapter will point out the advantages to be derived from the use of emery discs and bobs, and describe how such equipment can be made and used.

An Emery Disc Plate.—In the first place, the disc plate will have to be provided. The size of this must be determined by the capacity of the lathe—that is, the height of the lathe centres. If, for example, anything of a diameter of 8 in. can be swung in the lathe, then that could be the diameter of the disc. Preferably it should be of cast-iron, about $\frac{3}{8}$ in. thick, provided with a boss at the back, and tapped, or otherwise fitted, to the nose of the lathe mandrel. In order that it will run perfectly true on its face—an absolute necessity—it is advisable first to bore and thread the boss, and screw it on to the mandrel. Then turn up the face and periphery in situ. If it is decided to make this plate of wood—and the writer has seen some excellent results obtained by the use of this as an alternative to metal—it should be made from a piece of well-seasoned birch or best pine, free from knots, warps, or surface cracks. In this case the thickness of the disc might, with advantage, be increased to $\frac{5}{8}$ in.

The next thing to do is to cover the face of it with emery-cloth, or specially made emery discs, which are sold for the purpose. The use of the latter is not by any means a necessity, since the amateur can himself cut his own discs from ordinary sheets of emery-cloth, of the sort procurable at any ironmonger's. For general utility No. 2 grade will be most suitable, unless the work is to be finished instead of being roughed down. If the discs are purchased ready made, give the diameter of the discs and the grade of the abrasive. The cloth discs are fixed to the plate with ordinary glue applied very hot and thin; then a weight or pressure is applied on the face side until the cloth has regained its brittleness. In gluing the cloth to metal plates, the latter must be thoroughly cleaned from grease and made fairly hot, just hot enough that it can be handled, before applying the glue. Run the disc at the highest speed the lathe will permit. A piece of flat iron plate 3 in. square and $\frac{3}{16}$ in. thick riveted to one end of a short piece of square iron which will fit in the tool-holder will give an efficient rest for supporting the work

being operated on. Always run the disc to meet the top of the work.

An Emery Bob.—An emery bob is a different tool from an emery disc; but, as in the case of the latter, an amateur can make every part of it himself. The body of this is a circular piece of well-seasoned wood, say 6 in. in diameter by 1 in. thick. It must be mounted midway on a short spindle about $\frac{5}{8}$ in. in diameter, with both ends centred to run between the lathe centres. Each end is threaded to take a nut and washer to clamp the bob. When mounted on its spindle it must be trued up on the periphery and faces. Now take the circumference of this stock, and measure off a piece of new jointless leather belting, a trifle wider than the stock, and, say, $\frac{1}{2}$ in. longer than the circumference. Next soak this for half an hour in warm water, then well hammer it to render it pliable and to extract the moisture, and with a knife scrape from the hair side all the grey coating, thus exposing the grain of the leather.



Figs. 1 and 2.—Vertical Section and Part Plan of Mould for Emery Wheel

The leather now requires fixing to the periphery of the wood stock. Hold the latter firmly in a vice, have ready some hot thin glue, and begin by gluing one end of the leather, which must then be tacked down with small steel or brass pegs. Stretch well, and continue pulling the leather tightly round the stock, gluing and tacking as proceeding. The finishing end of the leather must be butted close against the other, and well secured with tacks, making a neat, close joint. Now with a nail punch go over all the tacks, and set them down about half way through the thickness of the leather. Leave for at least twelve hours to dry. When hard, mount in the lathe, and with a sharp turning chisel pare the face of the leather until it runs dead true.

The face of the bob has next to be coated with the abrasive material. Procure some No. 60 emery (it can be purchased at any ironmonger's quite cheaply, and 1 lb. is sufficient to coat a bob this size quite half a dozen times), and spread it thinly over a perfectly level plate. Then well cover the leather face of the bob with hot glue, take the mandrel in the hands, one on each side of the bob, and roll it along on the plate, backwards and forwards, using a fair amount of downward pressure in order to imbed the particles of emery deep into the face of the leather. When it has taken up all that it will, put the bob away in a warm, dry place for at least twelve hours. When it becomes necessary to re-coat the bob with abrasive, the old coating can be easily removed by moistening it with warm water, and scraping off with an old knife, taking care that the glue holding the leather to the wood stock is not softened.

It is not too much to say that a shilling spent in emery in covering a bob will do more work in quicker time than would a sovereign's worth of files.

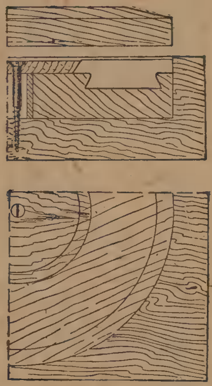
Making a Solid Emery Wheel.—For use in tool grinding, shaping castings, and other work where relatively large quantities of metal are ground off, wheels consisting of emery alone (except for the binding or cementing material which holds the emery particles together) are employed. Shop-manufactured emery wheels (1) contain an admixture of clay which, after the wheels have been shaped and dried, is vitrified by burning in a kiln for several days; (2) contain sodium silicate which is hardened by heating in an oven for twenty-four hours, thus bind-

ing the emery together; or (3) contain a cement, such as shellac, which on drying binds the cement sufficiently well for the lighter kinds of grinding. The vitrified wheel is the hardest and the shellac wheel the softest.

The amateur can easily and cheaply make his own emery wheels by the third of the processes above mentioned. First determine the size of wheel the lathe will take; one of 6-in. diameter will be a good size to start with. Then turn up a mould from hardwood (see Figs. 1 and 2), and a hub or centre from beechwood, with a dovetail rim as shown. Turn a lid to fit the mould; this will act as a cover to press in the composition after pouring. Fix the hub centrally in the mould, pour in the emery-powder dry to ascertain the amount required, take out the hub, and brush the mould and hub thoroughly with common blacklead (as used for fire-grates) mixed with ale. Brush over the lid and refix the hub. The wheel can be made fine, medium, or coarse as desired. For a medium wheel, use 3 parts of coarse grinding emery and 1 part of fine emery; next dissolve 3 oz. of brown shellac in methylated spirit at a temperature of 90° F., sufficient to form a thin paste, then heat it in a tin placed in a pan of boiling water. Boil in another tin, also placed in water, in the proportion of 2 lb. of, coarse emery and 10 oz. of fine powder, 1 oz. of cycle cement (the pitch and gutta-percha kind), and ½ oz. of resin. When boiling, stir in the shellac till the whole is of the consistency of treacle. The mould should be heated to a temperature of 150° F. and the composition poured in and well pressed home with any suitable tool, such as a small trowel, which should be previously warmed. The lid or cover should be placed over the mould and heavily weighted, and the walls of the mould should be made to taper upwards slightly so as to allow of the free withdrawal of the wheel.

To true up the wheel after casting, it should be mounted on the spindle and run at a good speed, using a hot iron and being careful not to remove more than necessary or to keep the hot iron too long in contact. Figs. 3 and 4 show a mould and wood centre for a face wheel.

Using an Emery Wheel in the Lathe.—It frequently happens that the possessor of a lathe requires to use an emery wheel and does not wish to go to the expense of purchasing an emery grinder. It is an easy matter to rig up an emery wheel so that it can be used between the lathe centres. The average metal-worker does not require to grind by means of an emery wheel very frequently, so if care is taken very little harm will be done to the lathe. Of course, all dust must be wiped from the bearings, the saddle, and all moving parts, otherwise the particles of emery will cause a great amount of wear to take place and seriously affect the accuracy of the machine.



Figs. 3 and 4.—Part Vertical Section and Part Plan of Mould for Emery Face-wheel

An easily made appliance is shown by Fig. 5. A spindle, fitted with two collars, an emery wheel, and a nut, is placed between the lathe centres, after fixing on one end the carrier A. A driving plate B, which is secured to the faceplate C by means of a short bolt, presses against the carrier and causes the spindle to revolve, together with the faceplate. The emery wheel D is held between two washers E and F, on the inside face of which two thin pieces of felt are glued, in order to ensure the washers having an elastic grip when tightening up the nut G.

The wheel is held by friction, this in

practice being found to give satisfaction. All dimensions for making the spindle are given in Fig. 6, but these can be varied to meet requirements. Mild steel is the best material for the job, and although cast-iron could be substituted, its use is not recommended. When mild steel is used there is no necessity for a forging, as the spindle can be turned from a piece of $1\frac{1}{4}$-in. round bar. The washers (Fig. 7) can be made from sheet material or cut off from the end of a bar after boring a short hole in the centre. The inside face of the washers must be made slightly hollow, thus affording a better grip of the wheel; on the hollow face a piece of felt should be glued. This will prevent the wheel being broken when the nut is screwed up, and will also compensate for any slight irregularity on the face.

The nut (Figs. 8 and 9) is an ordinary standard nut that has been made thinner. See that the wheel slips easily over the spindle and does not bind in the hole. If the spindle fits tightly and the wheel is forced over, it may happen that the wheel will burst when being used, and perhaps cause a serious accident.

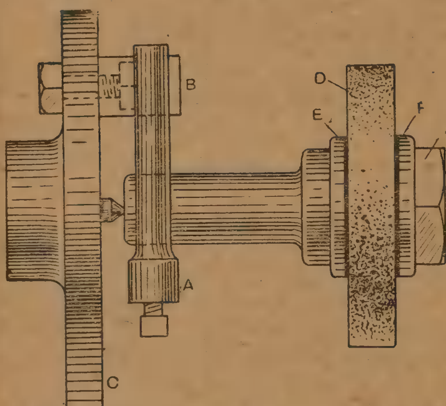


Fig. 5.—Emery Wheel Mounted in Lathe

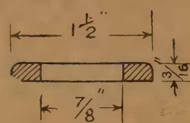


Fig. 7.—Section Through Clamping Washer

Figs. 8 and 9.—Clamping Nut

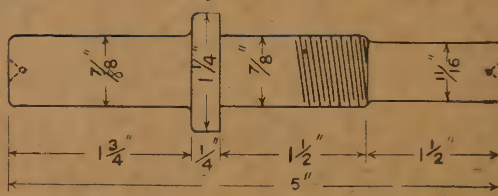


Fig. 6.—Spindle for Emery Wheel

The centre of a shop-manufactured emery wheel is generally filled with lead, and it is an easy matter to scrape away some of the metal by means of a knife or other suitable tool. Before mounting, the wheel should be suspended from a finger placed in the hole, and a slight blow should be struck on the wheel with a piece of metal. If a clear sound is given the wheel is in good condition; but if it sounds cracked it must not on any account be mounted, as the bursting of a wheel may endanger the life of the worker.

A good size wheel to use is one of 3 in. diameter by $\frac{5}{8}$ in. thick.

In practice a speed of about 5,000 ft. per minute on the periphery is recommended; but this is hardly attainable in a foot lathe, as in this case the spindle would have to turn about 3,800 revolutions per minute. The grinding will have to be done either on the under-side of the wheel or from the back of the machine.

Fixing and Laying Carpets

At removal times or for " spring cleaning " carpets have to be taken up and relaid, and there is quite a practical way of doing this without fuss or bother. Sometimes a carpet requires to be cut and refitted and this, too, can well be done by the home handyman. In fact, there is no reason why he should not make a carpet (this does not mean *weave* one, of course) if he is so disposed.

The cheapest carpets are the ready-made " squares " in certain stock sizes; there are also " squares " in some of the better qualities (Turkey and other Oriental makes), but when these are not adapted to the size or shape of the room the carpet must be made to the measurements required. First, it must be decided whether it shall be a " square " or a " fitted carpet " or a " fitted bordered carpet." The " square " is the least expensive, but the cost and trouble of the floor staining or surround must be taken into account. A " fitted carpet " fits close up to the walls, completely covering the floor. A " fitted bordered carpet " has a carpet border to match (usually 1 ft. 6 in. wide) seamed on all round, and

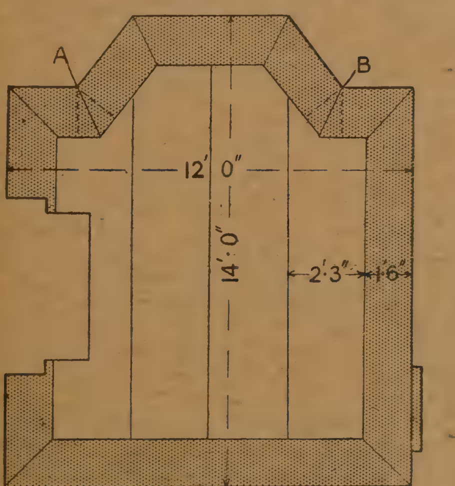


Fig. 1.—Plan of " Fitted Bordered Carpet "

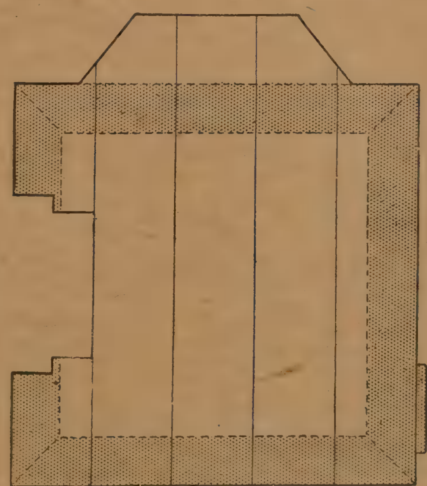


Fig. 2.—Plan of " Fitted Carpet " and " Bordered Square "

fitting close to the wall. The next consideration is whether it shall be a tapestry, Brussels, Wilton, velvet pile, Axminster, Turkey, or one of the less usual makes.

To determine the quantity required, a

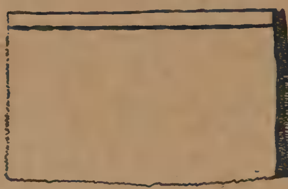


Fig. 3

Fig. 4

Fig 5

Figs. 3 to 5.—Stitching Selvedge Seams

scale plan of the room may be made, with the measurements, and the plan of the carpet drawn within it. But if the room floor is clear it may be planned out there (see Fig. 1), which shows all the seams of a "fitted bordered carpet." From this, the actual amount of the material may be measured. The body carpet is $\frac{3}{4}$ yd. wide, and the border $\frac{1}{2}$ yd. On all cut

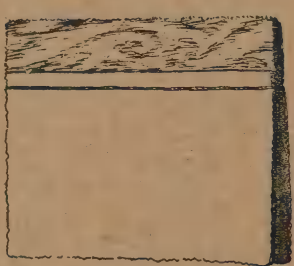


Fig. 6

Fig. 7

Fig. 8

Figs. 6 to 8.—Stitching Selvedge and Cut Edge Seams

edges $\frac{3}{4}$ in. may be allowed for turning back. In this particular case the quantities are: $14\frac{1}{2}$ yd. body material, and $16\frac{1}{2}$ yd. border material. These measurements are arrived at as follows: 2 inside lengths, each 11 ft.; 2 outer lengths, each 10 ft. 6 in. For the eight cut ends allow $\frac{3}{4}$ in. each = 6 in., the total being 43 ft. 6 in., or $14\frac{1}{2}$ yd. The border is measured on the outer edge and amounts to 45 ft.; but two of the mitres each incur an extra foot of stuff (see A B, Fig. 1), and another foot must be allowed to meet the hearth. For the eight other mitres and the fireplace—that is, eighteen cut edges —1 ft. $1\frac{1}{2}$ in. *must* be allowed, but it is as well to allow the 1 ft. 6 in. in case of waste in cutting the mitres. The border totals to 49 ft. 6 in., or $16\frac{1}{2}$ yd. Something may have to be allowed for matching the pattern at the seams, but often this can be managed without waste. It is necessary to cut a piece out at the hearth and a strip off this may be used to go under the door. The full size "fitted

Fig. 9.—Binding Turned-back Cut Edges

bordered carpet" is the most expensive, but a "bordered carpet" may be made the size of the body material, with the floor surround stained and polished, or covered with linoleum or felt.

The ordinary "fitted carpet" would be planned as shown by Fig. 2; in which the dotted lines indicate a plan for a "bordered square," leaving the bay to be stained or covered with surround material. Or a smaller square could be made, leaving the 18 in. margin all round. The quantities for these are quite straightforward to reckon.

The costs of the various qualities of materials are easily obtained from catalogues, etc., and therefore it is easy to reckon exactly what any kind of carpet to fit any room will cost.

In "making" a carpet the stuff may be cut and set out in position on the

floor. The stitching together may be done by hand with a needle and carpet thread, or on a sewing machine specially made for heavy work; tapestry, Brussels, or any of the lighter materials can be

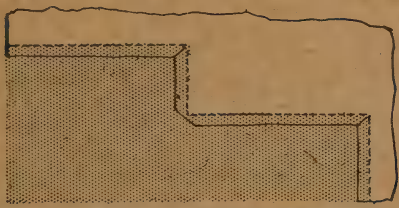


Fig. 10.—Cutting Carpet at Hearth-place

managed quite well on a medium machine, but anything as heavy as Axminster is rather trying.

The seams of the body carpet must be stitched first, the selvedges being kept evenly together, and the stitching about $\frac{3}{16}$ in. on, as shown by Figs. 3 and 4. The stitches need not be less than $\frac{1}{4}$ in. in length, and should not be too tight. Ultimately they have to open out flat, as shown by Fig. 5; but they should appear to be a little too tight for this at first, allowance being made for stretching.

The border stuff should be stitched as Figs. 6 and 7 show, the stitching being $\frac{3}{16}$ in. on the inner selvedge and $\frac{3}{4}$ in. from the cut edge of the body material, which is to be turned back and pressed,

Fig. 11.—Stitching on Carpet Binding

as seen in Fig. 8. The stitching of the mitres must be $\frac{3}{4}$ in. from both the cut edges kept evenly together; the edges are to be turned back and pressed, and bound with upholsterer's web (No. 12, English), as shown by Fig. 9, in which the centre dotted line indicates the stitched seam in the carpet, and the irregular dotted lines the edges of the turnings. The border seams, also, are bound in this way; it gives additional strength, keeps

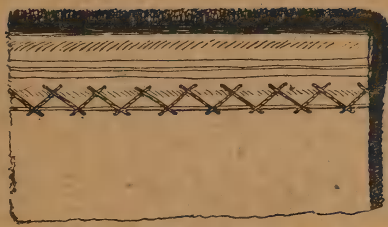


Fig. 12.—Back-stiching of Carpet Binding

them flat, and prevents the cut edges from fraying.

The hearth-place must be cut out, allowing $\frac{3}{4}$ in. over for turning in, and clipping the stuff at the corners as shown by Fig. 10. Carpet binding is then stitched on $\frac{1}{2}$ in. from the cut edge, in the manner shown by Fig. 11, to be turned over to the back and stitched, as in Fig. 12, this being easily and quickly done. From the piece cut out for the hearth, a strip may be cut to fit under the door; the selvedge is stitched to that of the border, the cut edge being turned in and bound. All cut edges of carpets should be treated in this way.

Fig. 13.—Ring Stitched to Carpet

Some carpets stretch considerably more than others, and in making a fitted carpet allowance must be made for this.

It is always an advantage to use "under-felt," especially with thin carpets, as it gives a softer tread and helps them to wear better; but for very thick carpets

"felt-paper" is sufficient. The under-felt or felt-paper is simply laid down in pieces and fixed with a few tacks to keep it from shifting whilst the carpet is being put down. The commonest way is to stretch

Fig. 14.—Slipping Carpet Ring over Nail-head

and tack it round the edges, especially in the case of "squares." Another way is to use "drugget pins" placed about 1 ft. apart, these resembling large-size drawing pins.

The best way to fix a "fitted carpet" is by rings, stitched on as shown by Fig. 13, about 6 in. or 8 in. apart, to fit corresponding nails (1 in. clout nails) driven into the floor; and in laying the carpet, a common gouge bit may be used to get the rings over the nail heads, in the manner shown by Fig. 14. This also stretches the carpet and avoids the use of a "stretcher."

There are special tools for stretching

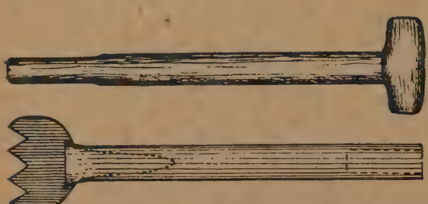


Fig. 15.—Carpet Stretcher with Detachable Handle

carpets, but they are not much used, workmen mostly preferring a home-made article of their own, such, for example, as that shown by Fig. 15. The blade is made from a flat piece of iron or steel about $\frac{1}{8}$ in. thick, and is inserted in a piece of brass-cased tube plugged with wood. Slots are filed in the end of the tube to let in the back edge of the blade, and it is then hammered slightly flat. A wooden crutch handle with the head covered with velvet is used for lengthening it, so that it may be used, when the worker is standing, by forcing with the knee. When kneeling, the habit is to use it short, driving the carpet up and bearing against the butt end with the breast whilst tacking.

The use of "stretchers" is, however, a source of risk to carpets, and on this account many workmen will not use them. Instead, they wear knee pads, go down on all fours, grip the edge of the carpet with both hands, and throw the weight of the body forward. This method is effective with practice, but is laborious and undignified.

Fig. 16.—Stretching Carpet with Spike-awl

It is essential that a carpet should be laid quite flat and straight, both for appearance and utility; and the following method is recommended. First stretch the carpet as nearly as possible to its correct position, and fix with a temporary tack at each corner. Then fix the centre of each side, stretching by means of a strong spike-awl, in the manner shown by Fig. 16. The awl is pointed so as to pierce between the threads without injuring them, and is stuck slightly into the floor, then levered forward to pull the carpet up. Each edge is then finished by working from the centre to the corners.

The taking up of a carpet is work which should be done without undue haste. In the case of a carpet of the shape shown in Figs. 1 or 2, first observe which way the seams run; remove the furniture from the wall to past the second seam, untack

the edge, and fold back at the first seam. Then lift the furniture back to the wall and fold at the second seam. The same is done from the opposite wall, and the carpet may be folded at the centre seam also. It will now be lying the length of the room under the table or bed, as the case may be, to be folded from each end to the centre, and should be immediately tied up with string.

A workman is often confronted with the task of raising a carpet from under very large, heavy furniture. To the uninitiated, the moving of a very large piece of furniture might seem to require the services of half a dozen men; but that is not advisable since there is the trouble of getting them, the difficulty of working in concert, and the danger of straining the article. Most large pieces of furniture are made in parts, and can be easily lightened. Take, for instance, a wardrobe, with full drawers and cupboards, of which the weight is very great. The drawers and shelves should be removed and it may be necessary to take off the doors, as they make a great difference in the weight and convenience in handling. In some cases the cornice might be lifted off and the side wings removed; but this is no great trouble, and the work can then be managed by one man. A wardrobe of ordinary size should be drawn forward about 2 ft. from the wall; then the carpet

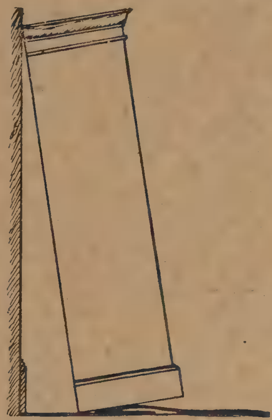


Fig. 17.—Withdrawing Carpet from Underneath Wardrobe

should be doubled under to show about 1 ft. of the boards; next the wardrobe should be put back to 9 in. from the wall and tilted back as shown by Fig. 17, so as to be able to draw out the carpet.

Make-shift Handle for Pad-saw

A TEMPORARY handle for a pad-saw may be made from a cotton reel—or, more correctly, a thread reel, as this is larger. With a chisel or even a sharp screwdriver and a hammer, two incisions or slots are made, one at each side of the central opening, as shown at A. The saw is then held upright and driven down in the slots by forcibly tapping the outer end. To avoid bending it, it is a good plan to place two strips of wood, about ½ in. thick, and an inch or so shorter than the saw, at each side of the latter, and to clamp or tie the three together. With care, however, this precaution is scarcely necessary. A pad-saw fixed in a make-shift handle in the way described is illustrated at B. It keeps on with singular tenacity, gives a firm grip, and stands a large amount of hard work.

Make-shift Handle for Pad-saw

Making Line Printing-blocks at Home

A LINE block is a type-high block of zinc, bearing in relief a photo-engraved and reversed image of an illustration consisting wholly of solids and whites. Thus, Fig. 1 (next page) has been printed from a "line block"—there is nothing but solid blacks and whites in it—whilst Fig. 2 (on p. 182) has not been so printed, since it includes a large proportion of "half-tones" corresponding to those in the photograph from which the block was made. The amateur often has occasion to multiply simple line drawings. He may need to illustrate an advertisement, to reproduce his own design for a Christmas card, etc. etc.; and should he be interested in amateur printing (as to which he should refer to later chapters) he will find a knowledge of line-block making of extreme utility. Many amateur photographers will take up the subject for its own sake, and because of the interesting experiments it makes possible. The photographer, indeed, will be prepared by the knowledge he already possesses for most of the processes, and some of his appliances, such as measuring glasses, etc., will be found handy.

Materials.—There is, perhaps, no process where so large an expenditure on appliances is possible, and yet where so small an initial outlay is necessary, as in the equipment of a plant producing line blocks. Expensive machinery is, of course, advisable when large quantities of commercial work are contemplated, but this chapter will deal only with the requirements of an amateur who wishes to avoid expense and yet desires to produce a perfect result. Ignoring, therefore, all time-saving appliances and difficult methods, and confining attention to the description of a simple method that can be easily grasped, it may be said that the outlay will come within the limits of a sovereign. Some of the materials are: 1 piece of polished zinc, 16 gauge; 1 piece of oak mounting wood; $\frac{1}{4}$ lb. of absorbent cotton-wool (first quality, free from grease); $\frac{1}{2}$ lb. of dragon's blood; $\frac{1}{4}$ lb. eagle etching ink; 1 dragon's blood brush; 1 qt. of commercial nitric acid; 1 composition roller; 1 atzpinsel etching brush (Fig. 1) (this is a round, mop-shaped brush of soft hair, generally marten fur, bound to a wooden handle by means of a waxed thread varnished with shellac); $\frac{1}{2}$ lb. of pumice powder; $\frac{1}{4}$ lb. of mounting nails; 1 pint of methylated spirit; $\frac{1}{2}$ oz. of potassium bichromate; $\frac{1}{4}$ lb. of shellac; 2 new-laid eggs; 1 lb. of American potash; 1 Norwich film (this film is not unlike tracing-cloth; it is transparent and one side may be highly glazed, while the other is matt, and it can be obtained through photograph material dealers). It is presumed that the worker has a few ordinary articles, such as a gas-ring, etc.

The Design.—First the design must be prepared, and it will be assumed that the amateur wishes to make a block for

insertion in a newspaper to advertise something or other he may wish to sell. He can, of course, have his advertisement set up wholly in type, in which case it has a good chance of being overlooked amongst the other matter, but the essence of advertising is to attract, and the columns of any newspaper will at once demonstrate the value of any illustration among the reading matter and the "pulling" effect of an advertisement that is printed in white letters on a black ground. Among the advantages to the amateur block-maker in the making of a white-letter design are: first, it obviates the necessity of making a negative from the drawing, provided that the drawing is made according to the method to be presently described; secondly, the etching process will occupy less time, because it will not be necessary to bite so deeply, and stronger acid may be used, because less metal (in the "walls" of the relief work) will be exposed to the action of the acid. The plate will not, therefore, get hot, which sometimes causes the resist to come off. Moreover, less acid will be used, and the necessity for cutting out large bare portions of zinc with a fret-saw is obviated. The plate itself will be less likely to cockle out of shape in the heating operations; and (all etchers will appreciate the last point) there will be no small detached portions of the design to protect.

Now as regards the size of the block: if it is to come within the space of a single column of a newspaper, about 2 in. wide and 1 in. deep will be enough. Cut a piece of the Norwich film a little larger than the design, and pin it to a board. Make up an ink composed of a solution of filtered gum arabic in which lamp-black has been mixed to the required consistency, and to which a few drops of glycerine have been added. More lamp-black may be added for brush work than can be used with a pen, and the ink should be tested for opacity before the drawing is started; the test work should also be dried quickly, and if it shows any cracks a few more drops of glycerine should be added; but beware of using too much glycerine, or the ink will remain tacky and stick to the plate when printing. In making the design, it is necessary to remember that it is a negative, and that the black strokes will show white in the finished proof; the outside edges of the block should be marked by black lines on the film; they will etch to a certain depth and facilitate the trimming of the metal. If the design is not drawn reversed, the film must be inverted when placed in contact with the sensitised zinc; the block, of course, must be a reverse.

Sensitising.—It will now be necessary to prepare the sensitising solution for the metal. The formula is: white of 2 eggs; water, 20 oz.; potassium bichromate, 200 gr.; liquor ammoniæ, a sufficient quantity. First split the egg-shells and pour off the albumen (the whites) into a bowl. The yolks are not required. After well beating the albumen, let it settle.

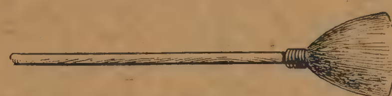


Fig. 1.—The Atzpinsel

Pulverise the potassium bichromate and dissolve in the water, add the albumen, beat up the mixture, and filter through cotton-wool. Now add liquor ammoniæ drop by drop, stirring all the time, until the colour of the solution changes to a pale lemon yellow. A piece of sheet zinc having been cut with a saw or draw-knife a little larger than the finished block is required to be, its polished surface should be cleaned with a piece of damp cotton-wool and pumice powder, rubbing with the grain of the metal (see Fig. 2). It should be rinsed free from pumice, and should then be grained by rocking it for a few seconds in a tray containing: water, 20 oz.; nitric acid, ½ dr.; alum, 1 oz. Having again rinsed it, rub it gently with a fresh pad of cotton-wool, shake off the superfluous moisture, and pour on some of the sensitising solution. Pour this off at all corners of the plate, pour on more solution, and shake it off in all directions by means of a rotary

motion in front of the fire or over a gas-ring until it is dry, but do not let the plate get more than comfortably warm. When dry, it is ready to print, and a very

Fig. 2.—Cleaning the Plate

strong printing-frame is necessary. A wedge pattern frame with a thick plate-glass front is not difficult to make, but failing this an ordinary photographic printing-frame will do for small blocks; but it is necessary to ascertain that there is no burr on the edge of the metal. The actual time of printing can only be found by experiment, but as a very great deal of latitude is possible, there will not be much trouble in this direction. Some sort of an actinometer should be used, and a very handy one can be made out of a tin tobacco-box with a flat top. A block of wood of the same depth as the box is placed in the box, a hole in the lid about $\frac{1}{4}$ in. wide is made, and a slip of yellow paper pasted over it; a piece of photographic P.O.P. is placed on the wood, and the box is placed to print in the light at the same time as the frame; the depth of the tint on the piece of P.O.P. when the frame is taken in is a guide for further exposures.

Inking-up.—The inking-up is a simple matter to the initiated, but the amateur is more likely to fail here than in any of the other operations, for if too little ink is used it will not take enough dragon's blood to become a perfect resist against the action of the acid; while if too much ink is used the design will develop smudgy or refuse to develop at all. The etching ink will not need to be thinned down, but it should be well distributed on a piece of thick glass with the composition roller before being applied to the plate. The metal plate should be taken out of the frame in a room not too strongly lighted, and the roller passed over it in all directions until it is covered with a thin even film of ink which should be just sufficient to make the plate look black. Now place the plate in a tray of cold water and rub gently with cotton-wool (Fig. 3) until the design shows clear and sharp. If any part of the design looks woolly, it requires more rubbing; but if it looks smudgy, it shows that the rubbing has been too hard or that the ink was put on too thick. If it refuses to develop, put a few drops of ammonia in the dish and leave it to soak for a few minutes; then rub again, and if it still refuses to develop it has been hopelessly over-exposed, and must be printed again. Presuming the plate to

Fig. 3.—Developing the Print

have come out all right, take off the superfluous moisture by dabbing the plate with a piece of chamois leather, and assist it to dry by warming it over the stove. Some shellac varnish should have been made up

by half filling a wide-mouthed bottle with orange shellac, and pouring into it some methylated spirit. When the shellac is quite dissolved the varnish should be of

Fig. 4.—Varnishing Back of Plate

the consistency of syrup. Make a hole in the cork and insert a stiff brush, and replace the cork with handle of the brush sticking half-way out of the bottle. The plate should be examined carefully, and any bare spots which should have been covered with ink must be touched up with an ink made of bitumen dissolved in turpentine. In the case of very open designs, where large spaces must ultimately be cut out with a fret-saw, these places should be painted in so as not to waste the acid, but do not paint too near to the design itself or trouble may ensue. The next step is to make a box to hold the dragon's blood; this should be about 18 in. by 18 in., by 4 in. deep, and should have a lid. The dragon's blood is placed in this box, and the plate is passed through the powder to cause as much as possible of it to adhere to the ink, and the superfluous powder is dusted off by means of the special dragon's blood brush. It is now held at one end by a pair of pincers, and heated over the stove until the powder melts and mixes with the ink. It should not be heated too much, but the right amount is easy to ascertain, as the powder being bright red to start with, turns immediately black on melting into the ink. While the plate is still warm, it is held by the pincers, and the shellac varnish painted all over the back to protect it from the acid on that side (see Fig. 4).

Etching.—Some kind of an etching tub is necessary, and the best form would be a stone tray. Another form can be made out of wood covered with pitch, but an ordinary photographic developing dish will serve the purpose after it has been painted over with brunswick black or shellac varnish. The zinc is immersed wholly in the acid and the tub is rocked. The acid is made very weak to start with, the following being about right: water, 40 oz.; nitric acid, 3 oz.; fish-glue, 1 drop. The object of the fish-glue is to make the etching smoother, and this effect is also obtained by rocking the tub, and brushing frequently with the atzpinsel (Fig. 8); this brushing is absolutely necessary in the process about to be described, as otherwise the dragon's blood sticks all over the plate, and the work is spoilt. With the first and second

Fig. 5.—Touching-up

etch, it is important to go to the right depth, but the exact amount varies with the nature of the work. If there are any very fine lines, the etching should not be more than the thickness

of writing paper, but for coarse work it will be possible to go much deeper. If it is not etched deeply enough, a "shoulder" will form near the top, and if it is etched too deeply, the fine lines will be undercut. When the depth is judged to be correct, the plate is taken out and the brushing continued under the tap for a few seconds. It is next dabbed nearly dry with the chamois leather, and held over the stove until quite dry and uniformly heated. The plate should not be made warmer than the hand can bear, and a good test is to lay it on the back of the hand for a few seconds, and if this causes no inconvenience it may be judged right to proceed. It is a good plan

Fig. 8.—Plate Lifted Out During Etching for Brushing

to mark the sides of the plate 1, 2, 3, 4. Next, the plate should be plunged into the dragon's blood and taken out at an angle with the side marked 1 uppermost; it is dumped on the bottom of the box once only to shake off the superfluous powder, then laid on the side of the box at a slight angle; the dragon's blood brush is held in the hand as in Fig. 6, and the powder dusted off in such a way as to cause it to form a ledge on all the sides against which it is brushed; that is to say, the brush is started on the side marked 1, and carried across to 2, but not back to 1. It is started again at 1, overlapping the part first brushed, and after the whole plate

Fig. 6.—Brushing the Powder Against the Lines

has been brushed over the operation is repeated. Fig. 5 shows the operation of touching-up.

The manner of brushing is important. The brushing should be carried across the plate, and the aim is to heap the powder against the lines and to clear the spaces as much as possible (see Fig. 6). The plate is now held level with the pincers, and carried carefully to the gas-ring, care being taken not to shake or jar it in such a way as to disturb the powder. It is held over the stove (see Fig. 7) just long enough to melt the powder and make it adhere, but

Fig. 7.—Burning in the Dragon's Blood

it must be cooled a little before the next powdering, the same test with the back of the hand being made. The powdering operation is then repeated, brushing the powder from the side marked 2, and so on, until the four sides are done. The acid bath is now reinforced with only as much acid as it is judged has been used up in the last etching, but the duration of etching is lengthened; if the first etch was completed in three minutes, the second etch should take about five minutes, the powdering process being then repeated; both the strength of the acid and duration of etching are doubled for the third etch. The powdering process is then repeated, and with the same strength of acid as when the third etch was begun, a fifteen minutes' etching will finish the job, unless it is desired to go deeper, when a fifth etch with still stronger acid can be given.

What is called a finishing etch is not necessary by this process as a general rule, but it will improve the appearance of the block and remove any "shoulder" that may have formed. The amateur is advised to avoid this "finishing" etch if possible; should it be thought desirable, it will be necessary first to clean the plate with a stiff nail-brush and a strong solution of caustic potash, dry the plate, and "roll" it up with the roller and etching ink. Then it is plunged into the dragon's blood, and the powder brushed away in all directions, not allowing any to heap up against the lines. The plate is now heated, but only just sufficient to melt the powder. The etching bath is reduced to the same strength as for the first etch, and two or three minutes' etch is given, after which the ink is cleaned off and the varnish scraped from the back of the plate. If desired, a proof can now be "pulled," an ordinary iron letter-copying press being very handy for this purpose.

The plate must be burnished and mounted on the special mounting wood, and this will be a simple matter if it is a white-letter block, when holes can be drilled in the letters and the nails driven in with a hammer and punch, but if the block contains large spaces that have to be cut out, this must be done with a fret-saw, and judgment used in placing the nails. The block must also be squared up, and it should now be the same thickness as the diameter of a new shilling piece, which is exactly type high.

Fig. 9.—Print from Line Block Made from Norwich Film; note the "Half-tone" Effect

A clever draughtsman may, by varnishing and scraping, get some beautiful effects with the Norwich film and then himself make a printing-block from it. Fig. 9 will indicate some of the possibilities of the process, this block having been made substantially, but not exactly, as described in this chapter.

Home-made Garden Rollers

THE garden roller shown by Fig. 1 is made of wood and sheet-iron, Fig. 2 representing a section through it.

Each end of the roller consists of two 18-in. discs A of hardwood 1 in. thick, placed with their grain crossing as shown and firmly screwed together. Exactly in the centre of each end a $\frac{1}{2}$-in. hole is bored, through which a $5\frac{1}{2}$-in. iron bolt B passes. On the inside of each end a 2-in. square iron bolt-plate C, with a $\frac{1}{2}$-in. square hole, is screwed, and on the outside there is a similar plate with a round hole to take the bolt straight through. Over the heads of the bolt and plates a piece of zinc or tin D should be nailed, to prevent the bolts being accidentally knocked in when fixing on the pulling frame, and also to keep particles of the ballast from working through on to the bearings. Be sure that the bolts have square shoulders to fit into the inside plates; this prevents them turning round.

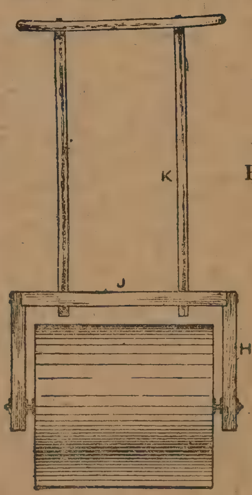
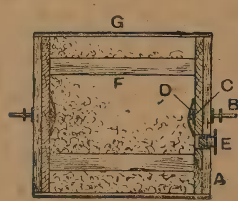


Fig. 1 (*to the left*).—Roller Complete

Fig. 2 (*below*).—Section Through Roller



Then a few inches from the bolt, with a good keyhole saw, cut a $2\frac{1}{2}$-in. round hole in one of the ends, through which the roller, when covered, will be filled. Save the piece cut out, and nail on to it an overlapping piece of zinc or tin, as at E, to admit of its being screwed down. The ends are clamped together, and a small hole is bored right through, 5 in. from the edge, above and below, in each end. Mark the edges of the discs so that the correct position can be found when about to nail the ends to the 2-in. square cross-pieces F, which are 1 ft. 4 in. long. A 4-in. square pencilled round the holes will give the position for the cross-pieces. Nail up with 6-in. wire nails; or, if desired, screws may be used.

The covering G is made up of strips of wood, 1 ft. 8 in. by 1 in. by $\frac{1}{4}$ in., placed across from end to end and nailed to the edges of the discs with 1-in. wire nails. When this covering is complete, glue thick

brown paper over the whole surface, to prevent the ballast working through. Then, on the top of this, nail down the sheet-iron, which should not be more than $\frac{1}{32}$ in. thick. It is easier to nail it on in two pieces, with flat-headed 2-in. iron nails, inserted at intervals of 1 in. To take the nailing of the joins of the sheet-iron, a strip of wood $1\frac{1}{4}$ in. square should be laid across from end to end, and let in flush with their edges; these strips should be opposite to each other, or wherever the iron joins may occur.

The pulling frame is made of 3-in. by 2-in. yellow deal planed smooth. The sides H (Fig. 1) are 1 ft. 4 in. long, and, when fixed with the cross-piece J, are 1 ft. 10 in. apart, inside measurement. This cross-piece is let in $\frac{1}{2}$ in. at the corners of the sides and tightened up with 4-in. coach-screws, two to each corner. The stem of these screws should not be more than $\frac{1}{4}$ in. thick. Three inches from the ends of the sides, $\frac{1}{2}$-in. holes must be bored to take the revolving bolts. A 2-in. square iron bolt-plate, with round holes, should be screwed on each side, as shown, to prevent the wearing of the wood by the revolving bolts, to which the nuts are fitted.

The shafts K are 2 ft. 8 in. long, and consist of ash garden rake handles. Holes must be bored in the cross-piece J of the pulling frame, 6 in. from the corners, to take the shafts, and small holes must also be made in the shafts and at each end of the cross-piece, to fix the shafts in position with wooden pegs. The handle-bar is of ash, 1 ft. 1 in. long, and is fixed on with 3-in. coach-screws having a $\frac{1}{4}$-in. stem.

The roller must be filled before the pulling frame is put on, the frame being screwed up in position after the ends have been placed on the bolts. The ballast consists of gravel, clay soil, and cinder-ash (sand will do, but this costs more), packed in firmly with a thick stick. The roller should be kept under cover, and wiped after use, to prevent rust. Paint the ends and the pulling frame a lead colour; the shafts and handle-bar need not be painted. Use vaseline or oil for the bearings.

This roller will not cost more than 7s. 6d. at the outside. The weight when filled is about 2 cwt.

A Concrete-filled Roller.—For this (see Fig. 3) a barrel must be procured with straight, not bulged, sides; and a soda barrel has been found to answer excellently. A piece of $\frac{5}{8}$-in. round iron forms the axle (Fig. 4). Its length will depend on the depth of the barrel; but it must project 2 in. at each end of the finished roller. If the cement of which the roller is formed sets firm, there is no fear of the axle working loose; but as an additional precaution, rivet two flat pieces of iron on this bar at right angles as shown. Two holes should be drilled in the ends for linch pins, though these are not necessary if the frame is made quite firm. Bore a hole in the middle of the bottom of the barrel, through which one end of the axle will pass. A narrow piece of wood must be strongly fastened on the top of the barrel, with a hole in its centre through which the other end of the axle may pass.

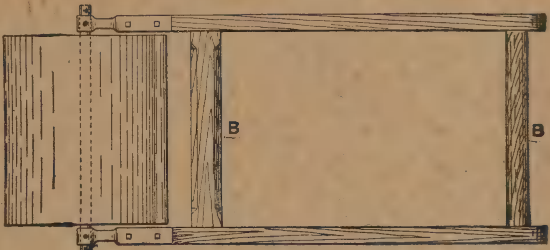


Fig. 3.—Concrete-filled Roller with Frame

The barrel should stand on a flat piece of ground during the process of forming the roller. Make a hole in the ground, into which the end of the axle will enter (see Fig. 5). Pass the axle through the bottom of the barrel into the hole in the ground. Allowing for the thickness of the bottom of the barrel and the piece of wood at the top, see that the axle projects equally at each end. Be sure that the axle is as near the centre of the barrel as possible.

The next process is to fill the barrel with portland cement and stones. The cement should be mixed with sand or clean gravel, in the proportion of one of cement to three of gravel. If gravel is used, it must be well washed to clear it of earth and dirt. To do this, wash a

Fig. 4.—Axle of Roller

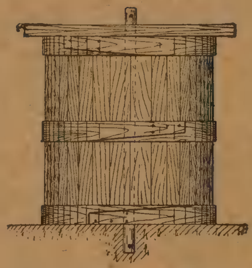


Fig. 5.—Barrel Set Up on Ground

couple of shovelfuls at a time in a bucket of water. Stir the water and gravel well together, and before it has time to settle pour off the dirty water. Repeat the operation until the water is fairly clear. Two good-sized buckets of gravel will suffice.

Some fair-sized stones (about the size of the worker's fist), washed clean, are also required. Mix up some cement in the proportion given, not too much at a time; mix it well with the gravel before adding the water, and do not make it sloppy—just plastic enough to work easily. Put a good layer of this in the bottom of the barrel to begin with. Then place some stones on this, allowing the cement to fill up well around them. Then more cement and more stones, until the barrel is full, pressing each layer of cement well about the stones, and finishing off the top with cement alone. Cover with a sack to keep out any rain, and leave for a few days till it sets.

One hundredweight of cement was sufficient for a roller made by the writer, so that the cost will be very little. It works easily, acts effectively, and it is doubtful whether an iron roller costing some pounds would accomplish better work.

Then get two pieces of iron $2\frac{1}{2}$ in. square with a hole in the centre of each, through which the axle will pass. Take off the top piece of wood which kept the axle in place, and drop one of these washers on the axle.

Next mix up some cement with fine gravel, and cement the end of the roller, bedding the washer in the cement, but not covering it. This washer provides something solid for the irons of the frame to work against. When this is dry, the barrel may be reversed, the bands removed, and all the wood stripped off. Then finish off the other end of the roller with a washer and cement.

The roller now requires to be finished off and made smooth. For this purpose get a fairly wide plank or board a little longer than the length of the roller, also two strong upright pieces, and fix the roller up as shown in Fig. 6. The piece of wood A should be fairly wide. Before fixing it in position, lay it on its supports, turn the roller, note the widest part, and fix the board so that when the roller is revolved, this part will just pass at this point.

See that the ends are equally distant from the centres of the axles. Pure cement should be used for truing-up the roller. Lay it on the board A, and press it against the roller as it revolves. A

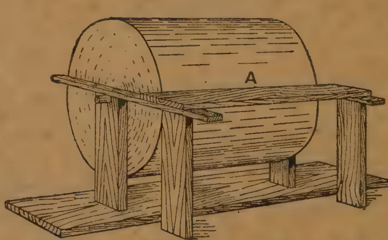


Fig. 6.—Truing-up the Roller

Fig. 7.—Bearing

little should be laid on at a time, and allowed to get fairly dry. As the roller begins to assume a cylindrical form, thinner cement should be used, until the roller is perfectly round and smooth.

To prevent quick drying and cracks, the roller should be kept covered

and protected from the sun whilst drying.

The framework need not be described, Fig. 3 giving a plan view of what is required. Instead of the iron bearings (see Fig. 7), a substitute could be made with two pieces of iron pipe which would just fit the axles. Fit these into the ends of the frame. The two bars B of the frame must have cheeks, and be wedged so as to keep the frame the exact width of the roller.

Restoring and Polishing Brown Boots

SOILED brown boots and shoes are restored in the following manner: First put them on boot trees or on the lasts on which they were made, but be very careful when inserting lasts, as the leather may have shrunk. If neither lasts nor trees are available, stuff the boots out to their proper shape with pieces of thin soft paper, pressing each piece in so tightly that a little pressure will not displace it; lace the boots, and so fill them right up to the top.

Brown leather that has been stained by dirt in wear needs merely to be washed with a very soft brush or sponge and a little soap and water. The water will not hurt them; but if they are calf, and not russia leather, be more sparing with the water.

If badly stained, wash in the same way with Clark's mahogany fluid (obtained from a grindery stores) diluted well with water. Propert's fluid is also good, but needs more care in using. Whichever is used, follow with an application of the same maker's cream. To keep the boots light, use white cream, unless any of the surface is worn, when it will need brown cream to bring it to the colour of the remainder.

The colour of badly darkened brown leather is lightened by applying a coat of very weak oxalic acid and water, using the brush freely, but hard. If not effective, add a little more acid to the water, and when the colour is as light as is desired, wash the acid off with water and let the boot dry in a cool place.

Sometimes dust accumulates on boot cream and mixes with it because the cream has not been properly applied, or because too much has been used. If the boots are on trees, the cream can be rubbed off with a dry cloth, but it is very hard work; and water, employed as above, will not hurt the leather if used carefully.

To use the cream, have a very small portion on a piece of clean white flannel and rub it on the leather very lightly over a wide surface as quickly as possible. This is continued till all the boot or shoe has been gone over. Then start afresh, and go over it again and again in the same way, always working the pad with a circular motion. After the first cleaning, the front will need the most treatment, as that portion of the shoe gets more wear, and the bending of the foot throws the cream out of the pores of the leather, the leather of these brown goods being grain side out.

Brown shoes do not need washing every time they are cleaned; but before they are creamed—in fact, every time they are taken off—they should be well dusted and polished with a soft cloth. After the cream has been put on one shoe, let it set while the other is creamed; then well polish with a soft cloth. This treatment will preserve the surface of the leather.

Ink Making

Galls for Ink Making.—Galls should always be bought whole, as, if already bruised, it is impossible to estimate their value. The best galls (Aleppo) have a warty surface, are blue or green, and should be heavy and free from holes (showing that they have been collected before the insect has escaped). English galls are of no value. For use, the galls are broken up into a coarse powder in an iron or bell-metal mortar.

Black Inks.—(1) For a good ink use for every pint of water 1 oz. of the best Aleppo ink galls, coarsely powdered. Boil for 3 or 4 hours, making up the water lost by evaporation, strain hot through calico, add about $\frac{3}{4}$ oz. of gum arabic per pint and boil until dissolved. While hot, strain into a stone or similar bottle and add, for every pint, about $\frac{3}{4}$ oz. of iron sulphate previously dissolved in a little water. To keep good, add to each pint 3 drops of creosote, and allow the ink time to mature its density of colour before using. (2) For a logwood ink, digest $\frac{1}{4}$ lb. of logwood chips in 3 pints of water for about 12 hours and then simmer until only 2 pints are left. When cold, strain or decant and stir in 20 dr. of yellow chromate of potash. (3) Waterproof ink generally contains borax and does not work very nicely. To make it, boil $\frac{1}{2}$ oz. of lump borax in $\frac{1}{2}$ pint of water in a covered pot, add 1 oz. of bleached shellac, stir until dissolved, and add enough pigment to give the required density; this pigment is vegetable black rubbed up on a palette with just enough water to form a smooth thick paste.

Blue-black Inks.—(1) Dissolve in 12 oz. of water 7 oz. of sulphate of iron and 20 drops of sulphuric acid; in a separate 12 oz. of water dissolve about 1 oz. of tannin. Dissolve in 1 oz. of alcohol (spirit of wine) 24 gr. of methyl blue. Add to the first solution the methyl and alcohol, then add the tannin water, and shake. This is ready at once. (2) Rub 6 parts of Prussian blue with 1 part of oxalic acid and a little water to a smooth paste and dilute with water. (3) Work together 15 parts of bruised galls, 5 parts of ferrous sulphate, 4 parts of iron filings, 200 parts of water, $\frac{1}{2}$ part of indigo, and 3 parts of sulphuric acid. (4) Digest together 7 oz. of bruised galls and $\frac{1}{2}$ oz. of bruised cloves for about a fortnight in 5 pints of water. Filter and add 3 oz. of sulphate of iron and 1 fluid dr. of sulphuric acid. Well shake until the ingredients dissolve properly, and add 1 oz. of indigo paste, and again filter if desirable.

Red Inks.—These are of either a cochineal or an aniline nature as a rule. For the latter, dissolve 1 oz. of aniline red in 10 oz. of spirit of wine, and after standing for about 3 hours add 70 oz. of distilled water. Very gently heat for some hours until the odour of the spirit of wine is no longer perceptible. Dissolve 2 oz. of gum in 8 oz. of distilled water and add to the liquor. An alternative avoiding the use of spirit is to take 2 parts of aniline red, 10 parts of gum, 100 parts of water and 10 parts of acetic acid, the procedure being practically as before.

For a cochineal ink, pour 4 pints of boiling water over 4 oz. of bruised cochineal. In another vessel boil 4 oz. of Brazil wood in 2 pints of soft water for half an hour. Let both of these stand for 2 days and then mix them together, adding a cold solution of 1 oz. of gum arabic in 1 pint of water. Strain after 7 days and bottle.

White Inks.—Dissolve 1 part of white gum ammoniac in 3 parts of acetic acid by means of gentle heat. Strain through muslin, add 1 part of Chinese white, and thin with acetic acid. Write with a quill pen or sable brush. Or simply mix with a weak solution of gum arabic any of the following: Flake white, French zinc white, white-lead, freshly precipitated barium sulphate, starch, or magnesium carbonate, first reducing them to an impalpable powder.

Green Inks.—A simple recipe is: Boil together 2 oz. of verdigris, 1 oz. of cream of tartar and ½ pint of water until the quantity has been reduced to one-half; then filter. A beautiful green colour is produced as follows: Dissolve 180 gr. of bichromate of potash in 1 oz. of water, adding while warm ½ oz. of spirit of wine; add concentrated sulphuric acid drop by drop until the liquid turns brown. Evaporate this liquor to one-half the quantity, and dilute with 2 oz. of distilled water. Filter, add ½ oz. of alcohol, followed by a few drops of strong sulphuric acid, and allow to rest until it assumes a beautiful green colour; get the proper consistency by adding a small amount of gum arabic.

Ticket Inks.—Glossy ink for ticket-writing is black pigment (say, gas-black or lamp-black) mixed with a solution of 4 oz. of gum arabic in 1 pint of water. The addition of a small proportion of aniline blue and black to the gum before the black is added assists in securing density. Waterproof ink (see next col.) must possess a binder that will not yield to water. Stephens's ebony stain is a cheap and convenient ticket ink.

For black japan ink, take finest lamp-black or gas-black, place some on a glass slab, and damp it with spirit of wine. Add some gum solution, and, using a palette knife, grind the pigment smooth; then further dilute with gum solution and place in a wide-mouthed bottle for use. For pen work, thin with spirit. Some workers grind the black in a saucer by means of a fair-size cork. Any dry pigment to be mixed with gum will work the better for being treated with spirit of wine. For coloured inks replace the black with any suitable pigment.

Waterproof Ticket Ink.—This employs a borax-shellac medium instead of a gum solution. To make the medium, boil 2 oz. of lump borax in 2 pints of water and add gradually 4 oz. of orange shellac, stirring constantly until dissolved. Take 3 oz. to 4 oz. of gas-black or lamp-black, saturate with some of the liquid, and grind to a paste; add to the solution and stir until dissolved. Leave to cool, strain through muslin and bottle. Any suitable pigment may replace the black.

For outdoor posters, printer's ink may be preferred, adding to it japanner's gold-size or terebene drier and diluting with turpentine or benzine. It is well first to test the ink on an odd piece of paper; too much turpentine causes a greasy edge round the letters. Or try mixing dry pigment stiff in japanner's gold-size and thinning with turpentine for a dead effect, and with oak varnish, terebene drier and turpentine for a glossy effect.

Bichromate of potash dissolved in as little water as possible and added to solutions of gelatine or gum into which the necessary pigment has been ground will, after exposing the work to sunlight, render the ink waterproof. Any surplus unused ink is useless.

Secret, Sympathetic or Invisible Inks.—In using these inks a clean pen should always be used, and a quill pen for preference, because chemical action is at once set up when iron is brought into contact with acids. All invisible inks will show on glazed paper, therefore unglazed paper should be used. In all cases the writing should be carefully done, allowed to dry, and in due course developed in the manner indicated.

(*a*) A weak solution of sulphuric acid (oil of vitriol) will be invisible on paper

when dry, but when the paper is held before the fire, the writing will char and appear of a brownish-black colour.

(*b*) A colourless solution of sulphate of iron (green copperas) or sulphate of copper (blue vitriol) is invisible when dry, but becomes visible (the iron blue and the copper brown) when dipped in a solution of potassium ferrocyanide (yellow prussiate of potash), and the latter will appear of a light-blue colour when exposed to the vapour of ammonia.

(*c*) A colourless solution of nitrate of lead is invisible on paper when dry, but turns a deep black when exposed to the vapour of ammonium sulphide.

(*d*) A thin solution of arrowroot or cornflour is invisible when dry, but becomes blue when held for a few seconds in the vapour of iodine solution. (Put a little iodine in a basin and add warm water.)

(*e*) A saturated solution of alum and lemon juice may be rendered visible by dipping the paper in water.

(*f*) Writing done with cow's milk becomes of a reddish colour when the paper is warmed at the fire or ironed with a hot flat-iron.

(*g*) The juice of a spanish onion or turnip turns brown when the paper is heated.

(*h*) Rice-water is invisible when dry, but appears of a blue colour by the application of iodine. Rice-water was frequently used as a secret ink during the Indian Mutiny.

(*i*) Nitrate of copper in weak solution becomes red by heating.

(*j*) Chloride of copper in very dilute solution (equal parts of blue vitriol and sal-ammoniac dissolved in water) is invisible until heated.

(*k*) A weak solution containing nitrate of nickel and chloride of nickel becomes green (when impure) or yellow (when pure) by heating.

(*l*) Solution of chloride of cobalt (cobalt 25 gr., water 1 oz.) is pink when damp, invisible when thoroughly dry, and green when heated ; when often heated or made very hot, the writing becomes a brownish-red.

(*m*) Solution of acetate of cobalt containing nickel or iron becomes green when heated, but when pure and free from these metals it becomes blue.

(*n*) Bromide of copper (1 part of potassium bromide, 1 part of blue vitriol, 8 parts of water ; discharge the colour of the blue vitriol by adding 1 part of alcohol) becomes visible when very slightly heated, and the colour disappears on cooling.

(*o*) Solid paraffin dissolved in benzol becomes invisible when the solvent has evaporated, but is rendered visible by dusting with lamp-black or powdered graphite, or holding in the smoke of a candle flame.

(*p*) Potassium iodide and starch (boil the starch and add a small quantity of potassium iodide in solution) becomes blue when nitrous acid is present in the atmosphere, or in the presence of ozone.

(*q*) A diluted acid solution of ferric chloride becomes red when exposed to sulpho-cyanic vapours, and the colour disappears when exposed to ammonia vapour. Alternate treatment as above causes the appearance and disappearance of the writing.

Iron-borings Cement for "Rust" Joints

To make about 2 lb. of borings cement, use from 25 to 32 oz. of iron-borings or powder, 10 to 12 drams of flowers of sulphur, and 5 to 6 drams of powdered sal-ammoniac. Mix all together, thoroughly dry, moisten with water again mix and allow to stand two hours before using. This cement is commonly used in jointing hot-water pipes in greenhouses and for filling up holes in rough ironwork.

Netting

Netting a Garden Hammock.—In netting a garden hammock a needle of one of the shapes shown by Figs. 1 and 2 is required. It may be made from a piece of $\frac{3}{16}$-in. pearwood, beech, or boxwood about 8 in. long by $\frac{3}{4}$ in. wide. In needles as shown by Fig. 2 the cord is wound round as when filling an ordinary shuttle, and for Fig. 1 the cord is brought round the end at A up one side, round the pin at B, and back the same side, the process being repeated on the other side of the

Fig. 1

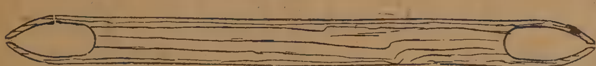


Fig. 2

Figs. 1 and 2.—Netting Needles

Fig. 3

Fig. 4

Figs. 3 and 4.—Mesh Stick

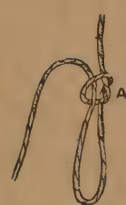


Fig. 5.—Loop in Meshing

Fig. 9.—Chain of Meshes

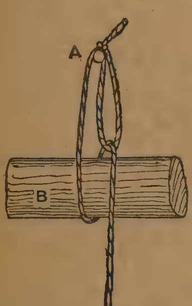


Fig. 6.—First Stage in Meshing

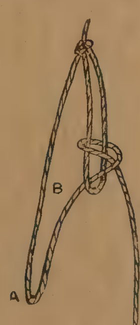


Fig. 8.—Third Stage in Meshing

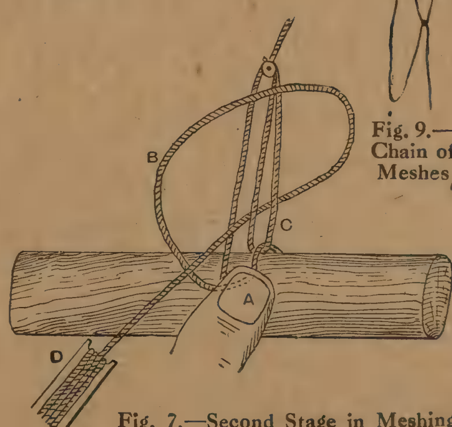


Fig. 7.—Second Stage in Meshing

needle. A mesh stick (Fig. 3) is made of hardwood or bone about 5 in. long, ¾ in. by ¼ in., and of an oval shape (Fig. 4).

At one end of the string to be used for the net tie a loop A (Fig. 5), and place the knot on a nail or hook fixed in some convenient position, as at A (Fig. 6). Place the mesh stick under the loop as at B, put the cord under it, then pass the needle through the loop and pull the cord tight. Now place the thumb of the left hand on the cord beyond the loop as at A (Fig. 7), and with a turn of the wrist of the right hand throw the cord to the position shown at B. Then pass the needle under the loop C, then through the bight of B and down as at D, and draw the knot tight, which should then assume the shape shown by Fig. 8. Hold the cord firmly with the thumb at A (Fig. 7) when pulling up knots, to get uniform meshes.

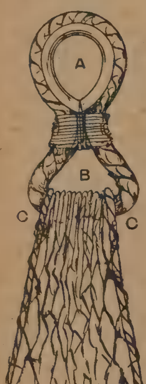


Fig. 11.—Hammock Clew

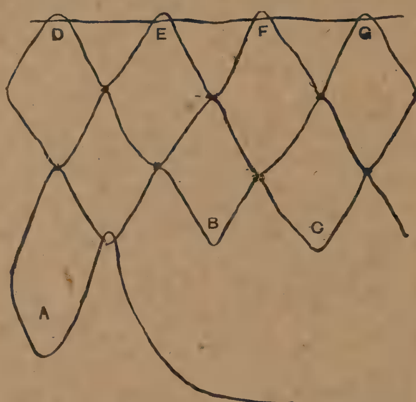


Fig. 10.—Beginning of Cross Netting

To continue the netting, the stick is withdrawn and placed under A (Fig. 8). The needle is then passed under the stick as in Fig. 6, and brought through the loop B (Fig. 8), and the process shown by Fig. 7 is repeated to form another mesh, this being continued to make a chain of meshes, say forty-five or fifty (Fig. 9), sufficient for the width of the hammock. The loop A (Figs. 5, 6, and 9) that was first tied is then untied, and it will then be found that all the meshes are equal in size.

Next the chain is opened out at right angles to the line in which it was made, as shown by Fig. 10, and working across is begun by making a mesh at A (Fig. 10), then at B, C, and so on, until the length of the first lot of meshes has been reached, when the net is turned over and another row of meshes worked until the one under A has been reached. Then the net is turned again and another row worked, and so on.

The meshes are worked as shown by Fig. 7; but at first, to ensure uniformity, it will be well to put the loops D, E, F, and G (Fig. 10) separately on the hook or nail as the meshes under them are made. After a little practice a cord may be reeved through the top line of meshes, tied into a loop, and passed over the knee and then over the foot, as the work progresses.

There are three ways of forming the ends. An ash stick may be used at each end to which the end meshes are looped and tied, and a piece of cod-line may be passed through the side meshes on each side and attached to the ends of the sticks. At each end a stout cord is secured to the stick in the form of a triangle for hanging the hammock. The second plan is to tie a number of cords together by doubling them in the centre and forming a loop, and each of the free ends, known as "nettles," is attached to one of the meshes of the net. The third, and perhaps the best plan, is to reeve a cord about the size of a little finger through the end meshes, and splice it into the form of a grummet, as shown by Fig. 11. A thimble A is fixed in the end to which the supporting cords are attached, and the cords which are reeved through the side meshes are spliced into the eye B at C. When these "clews" are used the net must be longer than for the sticks or nettles.

Netting and Fixing a Lawn-tennis Net.—For making tennis nets, macramé cord or evenly-wove string can be used,

the size of the mesh being $1\frac{1}{2}$ in. The net is 320 meshes long and 24 meshes deep. The corner is begun by taking two turns round the mesh; then knot and work a

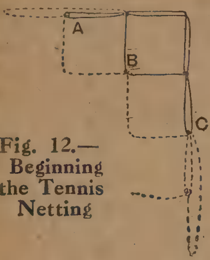


Fig. 12.—Beginning the Tennis Netting

Fig. 14.—Rubber Attachment for Cord

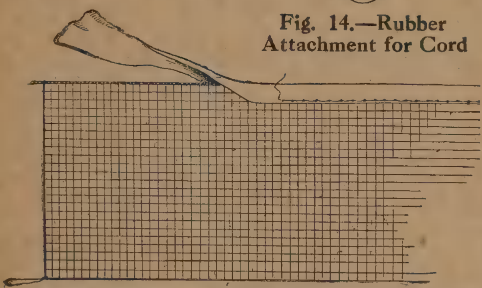


Fig. 13.—Method of Attaching Canvas Band and Cord to Netting

half mesh, then a whole mesh and a half mesh, taking up the bight of the loop first formed (see Fig. 12). Slip out the mesh and take up the last loop formed A, then the middle loop B, and the half-loop C; add another half-loop, and take it up as before, repeating this addition at each end of the diagonal row, as shown by the dotted line. When the twenty-fourth mesh in depth is reached, the additional stitch must be continued at one end and a reduction of one stitch at the other. To do this, hitch the string to the bight of the last loop formed without any turn round the mesh. Then continue for the length of 320 meshes, taking care to add and reduce correctly on the right sides. To square up the end, make the reduction on both sides.

The net must now be mounted on a strong cord for "setting up," for which about 44 ft. of light sash cord will be required. Put it on the stretch, and to it hitch or stop the net with twine. Copper wire, 7-ply, is often used for this ridge-rope, and keeps the net in better position without sagging. There will be 1 ft. of spare cord at one end and 3 ft. at the other. A strip of canvas 40 ft. by 6 in. must now be doubled over the cord the entire length of net and sewn to itself through the net, showing 3 in. or so on each side (Fig. 13). A piece of round india-rubber 8 in. or 10 in. long, having a small brass thimble seized in both ends, as shown in Fig. 14, should be used to prevent breakage in the event of the net being left out on the stretch in the rain or damp. This rubber is attached by one thimble to the shorter end of the cord; the other thimble is passed over a hook on one of the standards, as shown in Fig. 15. Both standards are fitted with sheaves in their heads about $2\frac{3}{4}$ in. diameter, so that the cords may be placed on the sheaves without any reeving. The other standard is fitted with a small ratchet-winch and handle (see Fig. 16), by which the net is stretched in place by the longer end of the cord.

The standards may be fixed up with

Figs. 15 and 16.—Standards with Hook and Ratchet Winch Respectively

guys and pegs like tent lines; but it is usual to sink cast-iron tubes into the lawn to receive the standards. These standards are 3 in. in diameter and 3 ft. 2 in. above the ground.

Woodworking: Dovetailing

The dovetail joint is very extensive both in its application and variety. Where strength and good construction are required, some form or other of it seems to be indispensable.

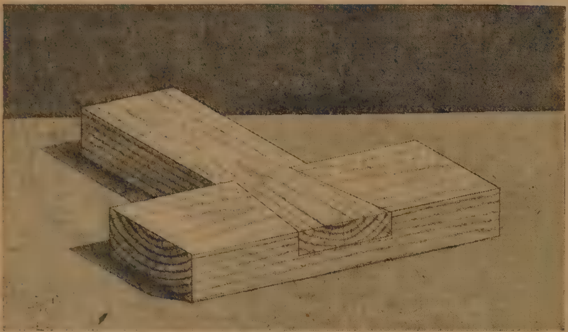


Fig. 1

Half Lap Dovetail. — This joint, varied in form to suit circumstances, is employed for connecting parts of framing together. Fig. 1 shows the joint completed, and together, and Fig. 2 when separated. At Fig. 3 the piece of wood is shown set out, and the inset shows the waste sawn from the under-side of the dovetail pin, and also the two small shoulders sawn. The lower view shows the pin completed. The sides of the pin should be pared exactly to the lines, the method of doing this being shown in Fig. 4. After the pin is prepared, it should be placed in position over that part which is to form the socket, and, keeping the shoulder of the pin piece close to that of the socket piece, the shape of the pin should be accurately scribed on the socket piece, as indicated in Fig. 5. Then the saw kerfs should be made just inside the lines—that is, in the waste of the socket—as shown in Fig. 5.

Single Dovetail Joint.—This joint is shown with the parts together and separated at Fig. 6, and Fig. 7 shows three distinct stages in the making. It will be noted that the two half pins are set out and made first. Having

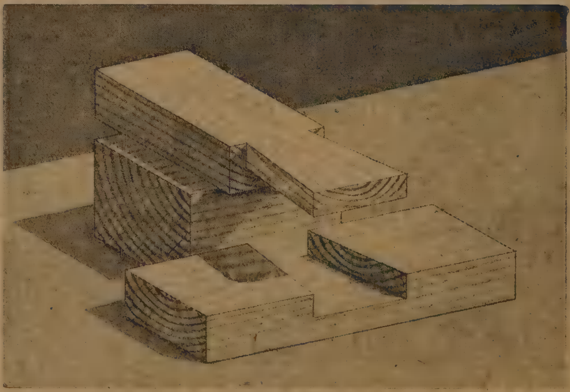


Fig. 2

Figs. 1 and 2.—Half Lap Dovetail

sawn for the two half pins, the waste may be mortised out with a mallet and chisel; or, if a small bow-saw is handy, most of the waste can be sawn out, as indicated in Fig. 9, sawing, of course, a little from the line. Then, with a sharp, thinly ground chisel, pare from each side just to the lines. A good method of holding the chisel with the left hand is shown in Fig. 10; the little finger rests on the work, whilst the other fingers and thumb hold the

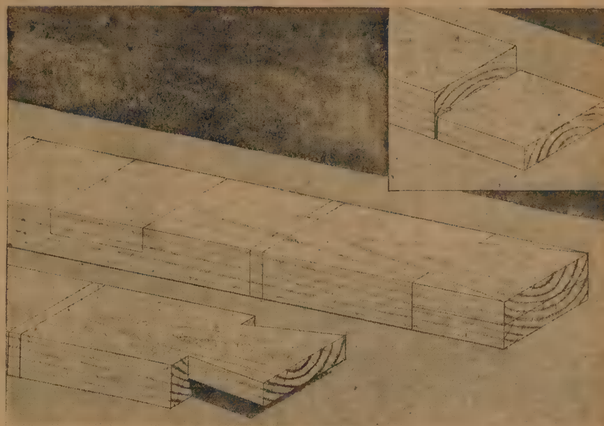


Fig. 3.—Making the Half Lap Dovetail

Fig. 4.—Paring Sides of Pin

chisel, keeping it in an upright position and preventing the edge reaching to the other side as the chisel is being driven forward, either with the right hand grasping the handle, or using a mallet and striking with light blows. The piece having the two half pins should now be placed on the piece that will have the two half sockets, so that the pins just touch the scribed shoulder line, then the shape of the pins can be accurately marked with the marking awl, as shown by the two views in Fig. 8. These lines should now be joined at the end by two lines parallel to the edges; these may be done with the gauge or by the method shown in the example of box dovetailing. The shoulders can next be sawn, and the joint fitted together.

The joint shown at Fig. 11 is the reverse

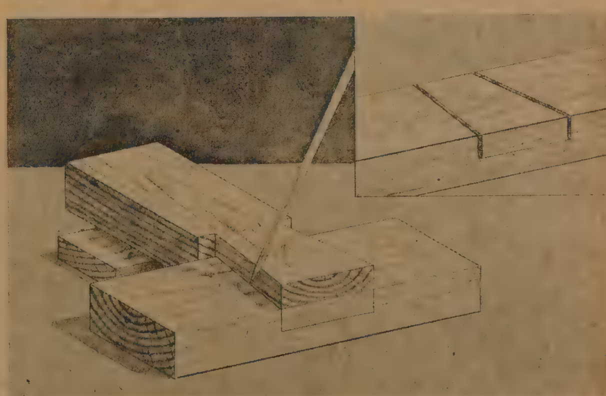


Fig. 5.—Marking Socket from Pin (Inset, Socket Sawn)

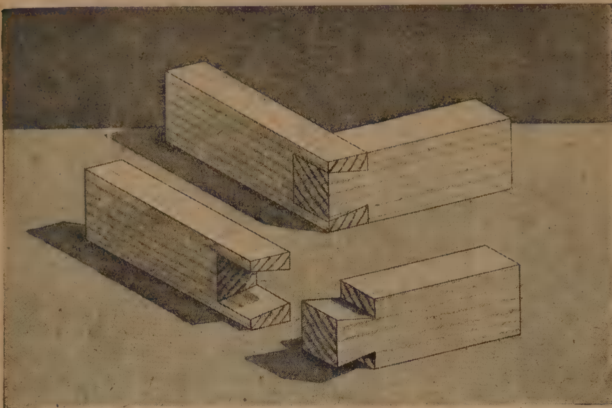


Fig. 6.—Single Dovetail

of the one just described. It has a full dovetail pin and a complete socket. To make this joint, the best method will be to mark out and make the socket first, and then apply it to the end of the pin piece and scribe the shape of the end of the pin from the socket, as indicated in Fig. 12.

Common or Box Dovetail Joints.—For dovetailing generally, the writer strongly advises the amateur to set out each piece truly to length, and then to fix it in the vice so that the end is level. Plane overhand with the smoothing plane, so that the end is quite square to the edge and face side. Another method which is better for many purposes and more expeditious is to plane the ends true by the aid of a shooting block, as represented in Fig. 13. Having done this for the joint shown together by Fig. 14 and apart by Fig. 15, the pieces should be scribed round for the shoulder lines, as shown in Fig. 16. These lines, obviously, will be at a distance from the ends just equal to

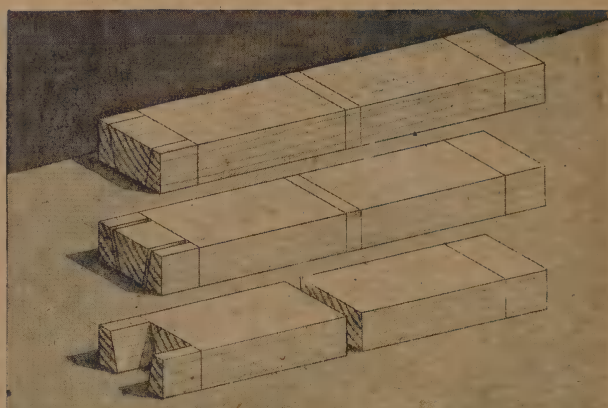


Fig. 7.—Three Stages in Making Single Dovetail

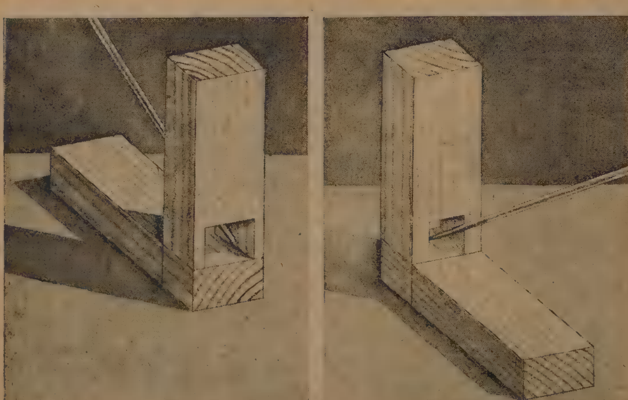


Fig. 8.—Front and Back Views Showing Marking of Sockets from Pins

the thickness of the stuff. The marking gauge used for the thickness when planing-up the stuff will be found useful for marking off these distances, if it has not been re-set.

There are two general methods advocated for the making of this kind of dovetail joint, and as each is put forward as the best by equally good authorities, both methods will be illustrated and explained, the reader pleasing himself as to which he adopts. The

writer, who has had great experience, has found that for general purposes much of the best work of both professionals and amateurs is done by first making the pins and then marking the sockets from these. Start by marking off from each edge on the shoulder line half the thickness of the outer side of the pin, as shown by the two extreme points marked C in Fig. 16; then, with a pair of dividers, accurately divide the space between the two outer

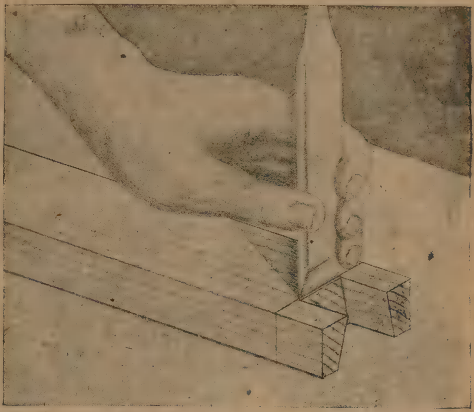


Fig. 10.—Holding Chisel when Finishing Socket

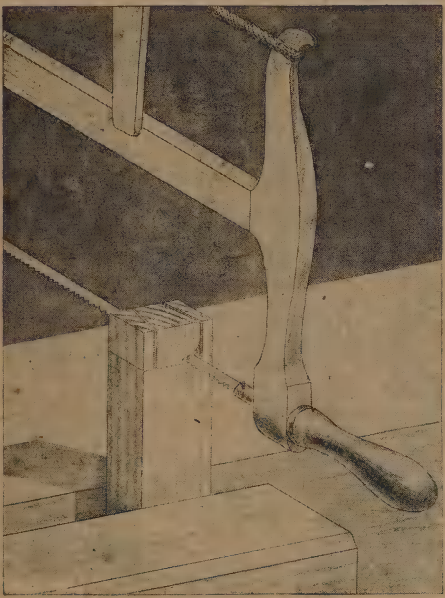


Fig 9.—Sawing Out Waste of Socket

points into the number of equal parts required; in the example shown it is three (of course, the number will vary with the width of the stuff and other circumstances). Next set the dividers to half the thickness of the outer sides of the pins and mark off half the thickness of the pins on each side of the centre dots (marked C). This outer thickness of the pins may be $\frac{1}{4}$ in. for stuff $\frac{3}{8}$ in. to $\frac{3}{4}$ in. thick, for thinner wood it would be rather less than $\frac{1}{4}$ in., and for thicker wood more than a $\frac{1}{4}$ in. With a small try-square adjusted so that its stock is against the end of the work and its blade resting on the face side, the lines for the setting out of the outer side of the pins can be made with a marking awl from each of the marks made on the shoulder line, as represented in Fig. 17. The work should next be placed upright in the bench screw with the marks just made outwards, as shown in Fig. 18; then these are joined by means of a bevel set to the angle for the shape of the ends of the pins, and the work is then marked out with the bevel and marking point, as shown in Fig. 18. With regard to the proper angles for dovetails, these should not be less than 10 degrees or more than 20 degrees splayed on each side of the centre line, as shown

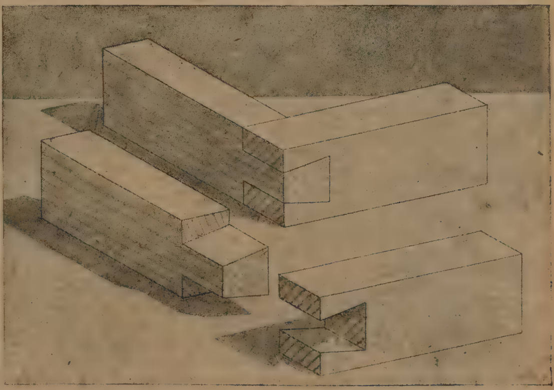


Fig. 11.—Alternative Form of Single Dovetail

at A and B (Fig. 19). A common fault with amateurs and beginners is to make the splay of their dovetails 30 degrees, and even up to 45 degrees, as shown at forced out, besides being liable to further breaking away of the grain, whilst the joint is being cleaned off, that is, planed or smoothed off. A very good method of

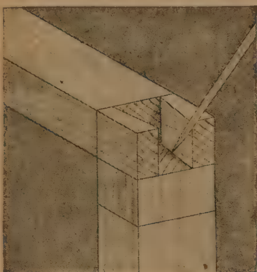


Fig. 12.—Marking Pin from Socket

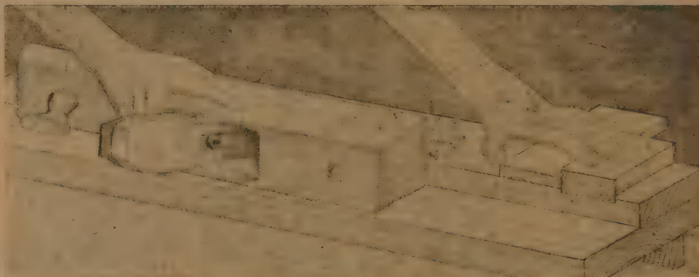


Fig. 13.—Shooting End Grain for Dovetailing

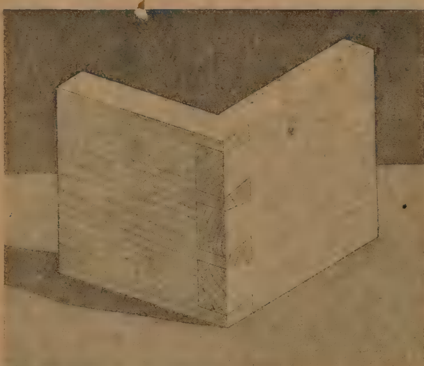


Fig. 14.—Common or Box Dovetail

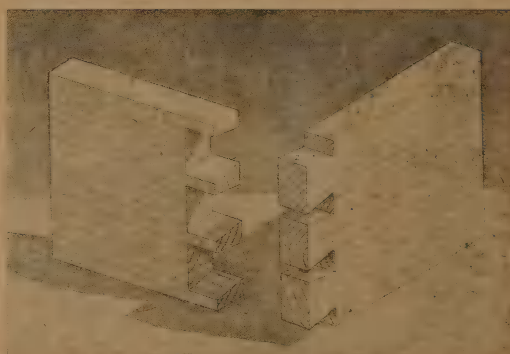


Fig. 15.—Box Dovetail Apart

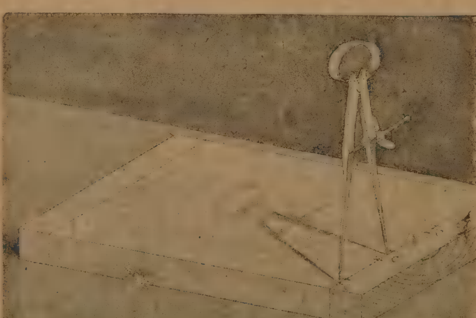


Fig. 16.—Setting Out for Centres of Pins

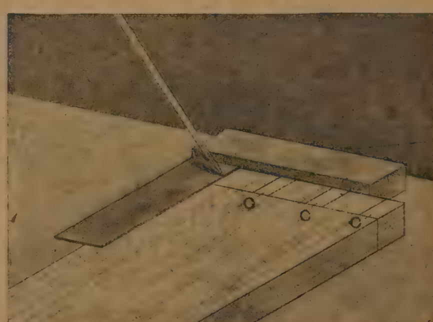


Fig. 17.—Scribing for Outer Edges of Pins

C, which not only mars the appearance of their work, but introduces a source of weakness, because if the pins only fit fairly tightly in the sockets, the short grain of these, which is indicated at D, is setting the bevel is to obtain a piece of board and set up a square line, as shown in Fig. 20, and mark off six units—six ½ in., say—and then to the left or right along the edge mark off one unit, then

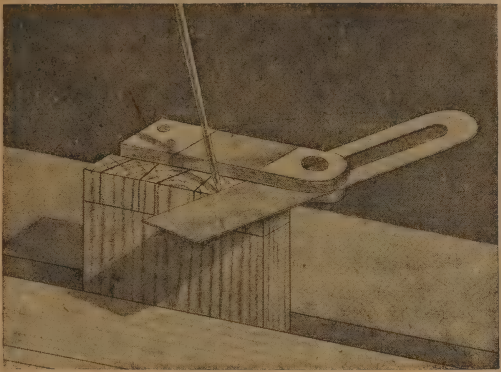


Fig. 18.—Marking Out Ends of Pins

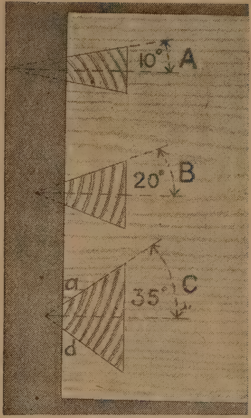


Fig. 19.—Angles for Dovetails

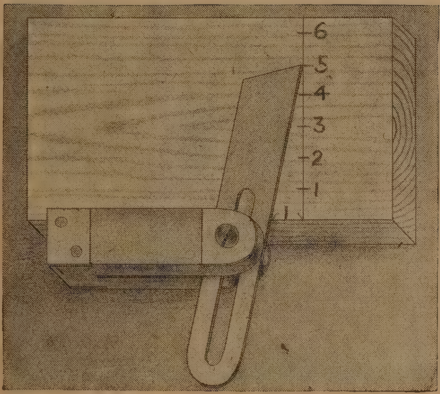


Fig. 20.—Setting Bevel to Angle for Dovetailing

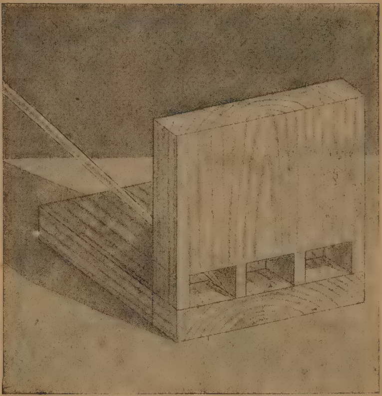


Fig. 21.—Marking for Sockets (Front View)

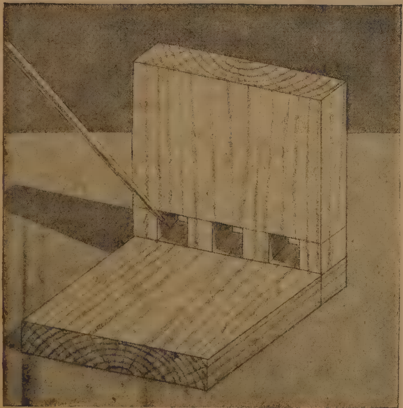


Fig. 22.—Marking for Sockets (Back View)

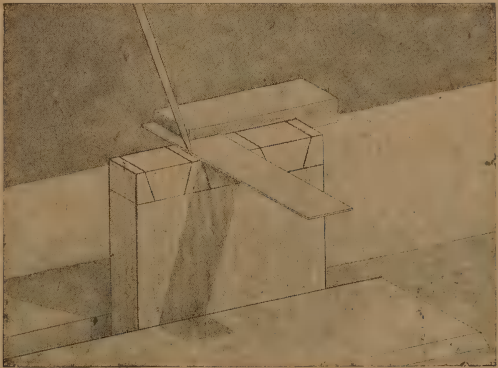


Fig. 23.—Squaring Across End of Socket Piece

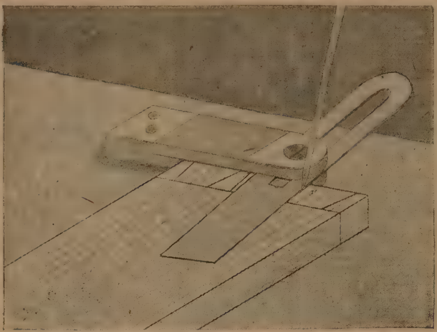


Fig. 24.—Marking Out Sockets on Face Side

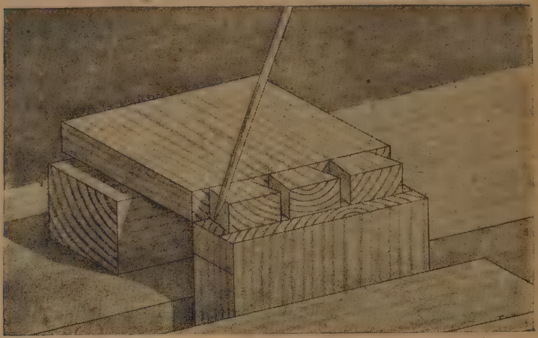


Fig. 25.—Marking Out Ends of Pins from Sockets

drawing the splay line shown, give a line so that setting a bevel to it as shown makes the inclination—or angle—of the blade with the stock 6 to 1, which is probably about the best angle for dovetailing.

Of course, by setting up 5 units or 7 units the angle would be varied to 5 to 1 and 7 to 1. The pins having been set out, the sawing should be done with a dovetail saw in the waste between them; then the bulk of the waste can be removed by mortising, or with a bow-saw; next, with a sharp, thinly ground chisel, the shoulders are pared exactly to the lines, of course from each side. The inner parts of the pins can now be adjusted to the shoulder line of the socket piece, and with a marking awl used from the inside, as indicated in Figs. 21 and 22, the exact shape of the sockets can be marked out from the pins. The reader may wonder why the awl should not be used from the outer side, but if he tries this he will probably find that there is a difficulty in keeping the marking point close to the pin, because the straightness of the grain of the socket piece will tend to make the point follow with the grain, whereas by marking from the back this very action of the grain keeps the point close to the pin. The socket piece should now be placed vertically in the bench-screw and lines continued (from those just made on the inner face) square across the end, as indicated in Fig. 23. The sawing, mortising and paring should next be accurately done, after which the joint will be ready to be fitted together, a good fitting joint depending on careful workmanship.

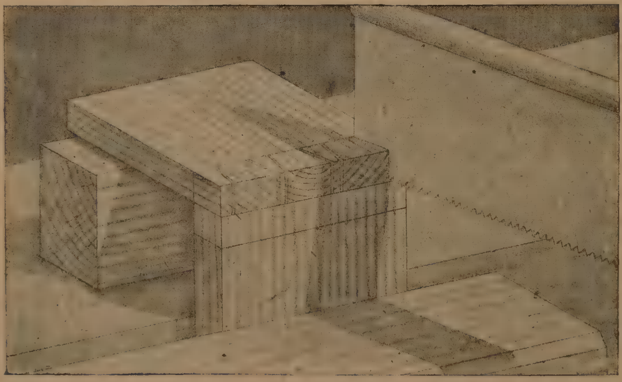
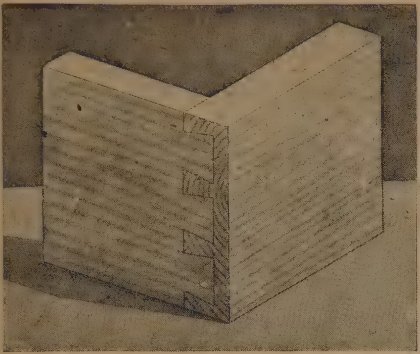
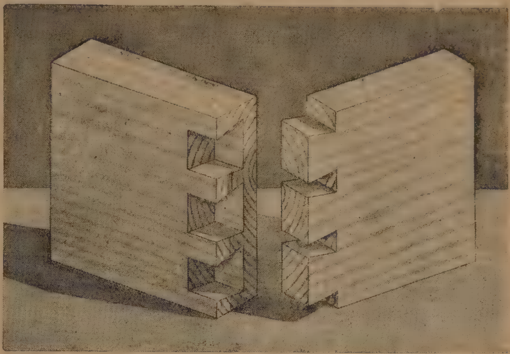


Fig. 26.—Marking Ends of Pins with Saw

The method of making the sockets first will now be illustrated and explained. Along the shoulder line mark off from each edge half the width of the socket; this will vary from $\frac{3}{8}$ in. to $\frac{3}{4}$ in., or even more, according to the thickness of the stuff, as was previously mentioned in the case of the pins. Next exactly divide the space between these two dots so as to obtain the centres along the shoulder line of the other sockets; as in the case of the pins, set the dividers to

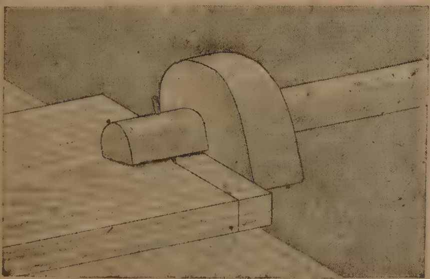


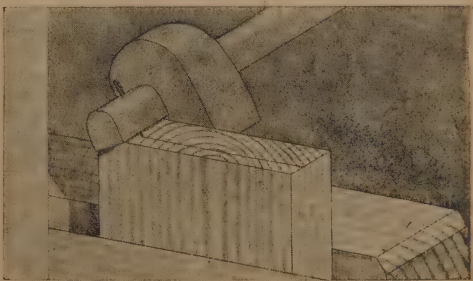


Figs. 27 and 28.—Drawer or Lap Dovetailed Joint, Together and Apart

half what is going to be the width of the sockets along the shoulder line and mark off these distances each side of the centre dot; then, with the bevel set to the proper angle, mark out the sockets on the face side, as indicated in Fig. 24. Placing the piece in the bench screw with the end horizontal, square lines across the end, as shown in Fig. 23, after which carefully saw exactly by the sides of the lines in the waste, and then, by sawing the two small shoulders of the half sockets and mortising and paring the whole sockets, the piece will appear as in Fig. 25, where it will be seen that the pin piece is placed vertically in the screw, and the socket piece is carefully adjusted and held in proper position, so that the shape of the pins can be marked from the sockets (see Fig. 25). From the marks made on the end of the pin piece, lines are squared from the end on the face side to the shoulder, similar to the example shown in Fig. 17

Fig. 26 shows an alternative method of marking the pins from the sockets by means of using the end teeth of the saw. The pieces are held together with the left hand, and the saw is placed in each kerf in turn and lightly drawn towards the operator, the two or three teeth at the end making light indentations. Then with a try-square, lines square to the end are made as previously described. The pins are next sawn so that the whole of the light kerf mark just made is left in on the end of the pin. The reader will see that this must be most carefully done, as otherwise the half pins would be too small by the amount of one saw kerf, and the whole pins by two saw kerfs. This method is all right, and often quite easy to some expert mechanics who have practised it for years, but as a rule the amateur does not produce the accurate results that he can by using the marking point throughout. The writer would emphasise the fact that good dovetailing can only be pro-





Figs. 29 and 30.—Gauging Shoulder Lines of Side and Front Pieces

duced by adopting the most accurate methods, and experience will show that the adoption of pencil lines instead of cut or scribed lines does not make for accuracy.

Drawer or Lap Dovetailing.—A completed joint of this kind is shown at Fig. 27, and the pieces ready for fixing together at Fig. 28. Drawer fronts and their sides are nearly always connected by this form of joint; it is also used when the jointing is not desired to be seen on the outer face. The pieces, having been truly planed up to the breadth and thickness, should be set out for length, scribing lines all round, and then planing truly to these either with the smoothing plane, overhand, or shooting to the lines by means of a plane and shooting block.

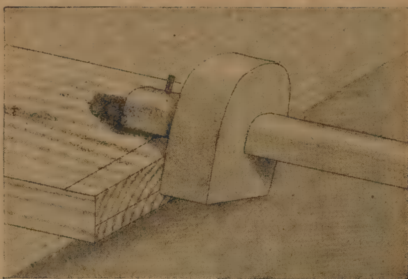


Fig. 31.—Gauging Distance on End of Front Piece

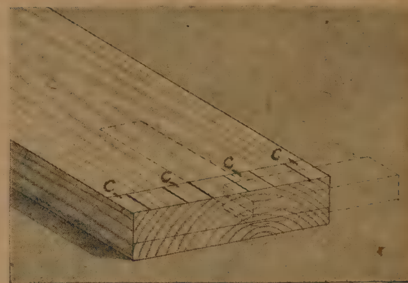


Fig. 32.—Setting Out for Pins on Front Piece

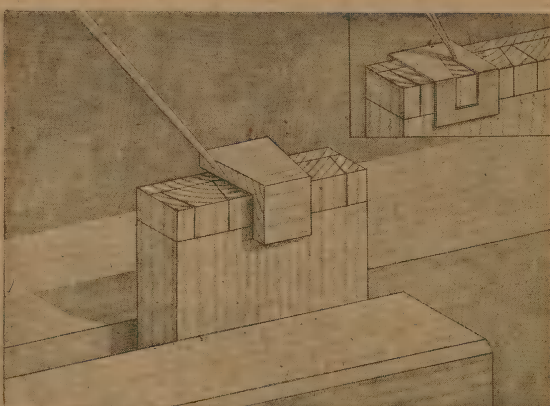


Fig. 33.—Setting Out Splay of Pins

Setting Out.—As will be seen, the side is thinner than the front. The distance that the side laps on to the end of the front piece is usually a distance equal to the thickness of the side. Therefore, setting a gauge to this amount, a

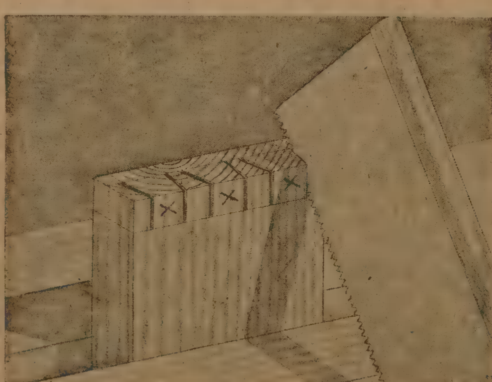


Fig. 34.—Sawing for Pins

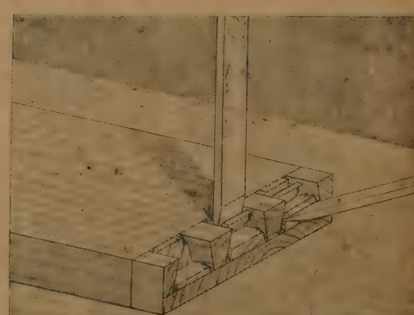


Fig. 35.—Mortising Out Waste Between Pins

gauge line can be made round on the faces and edges from the end of the side, as indicated in Fig. 29, this making the shoulder line without using a try-square. Without altering the gauge, use it so that the stock is worked against the inner surface of the front piece and make the gauge line on its end, as shown in Fig. 30. Then, turning the piece with its inner side uppermost, make a gauge line with the gauge — without altering the gauge—as shown in Fig. 31. The pins can now be set out. As will be observed, the larger parts of the pins will here have to be set out along the shoulder line; the thickness of these parts of the pins will vary from $\frac{3}{8}$ in. to $\frac{3}{4}$ in., according to the thickness of the sides. As a rough guide, the thickness of the larger part of the pin should be three-quarters that of the thickness of the side. On the shoulder line mark off half the thickness of the outer pins from each edge. With dividers, find accurately the centres of the intermediate pins, as indicated by the dots C in Fig. 32. Next set off on each side of these dots half the thickness of the pins, and with the try-square and point complete the pins on the inner face, as indicated in Fig. 32. Placing the piece vertically in the bench-screw the shape of the ends of the pins can be marked out by the aid of a bevel, as shown in the case of box dovetailing, or a wooden template can be made and used for the purpose, as shown in Fig. 33. Another good expedient is to make a template of zinc or even tin, and use it as shown in the smaller view in Fig. 33. With a fine tenon saw or, better still, a dovetail saw, carefully make kerfs just by the sides of the lines in the waste, and mark these parts with a **X**, as shown in Fig. 34. Cramping the piece to the bench by some means, the waste parts should then be roughed out by vertical and horizontal mortising, as indicated at Fig. 35, cutting them away to within about $\frac{1}{16}$ in. of the gauge lines. Next fix the work vertically in the vice and pare the sockets accurately

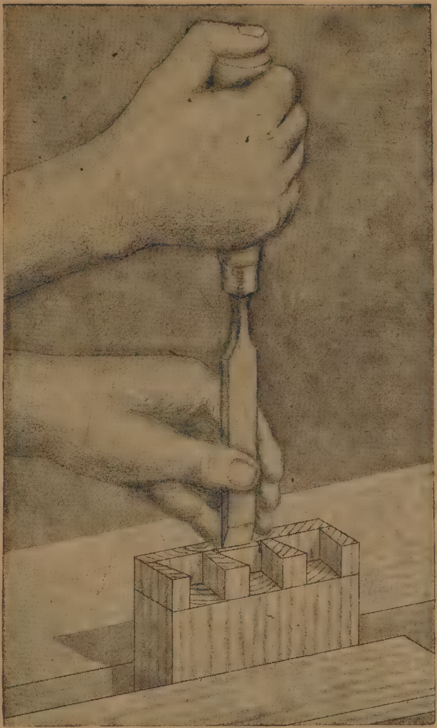


Fig. 36

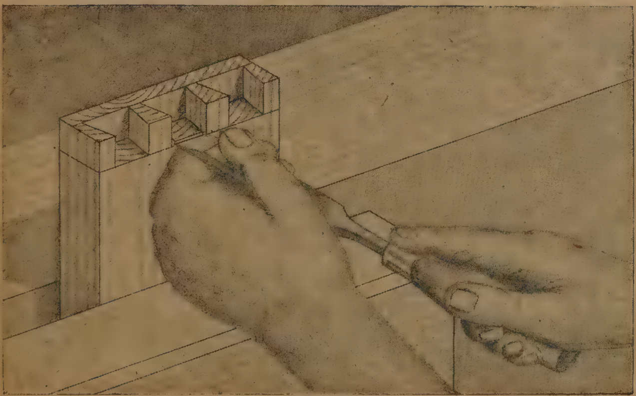


Fig. 37

Figs. 36 and 37. — Vertical and Horizontal Paring for Finishing Sockets Between Pins

to the lines by vertical and horizontal parings with a thinly ground chisel, as shown by Figs. 36 and 37. To produce a well-fitting joint these sockets should be pared very slightly "under"—that is, when the parts are pushed together the sides of the sockets should not quite touch the inner parts of the side, as shown in an exaggerated manner by Fig. 38. Beginners frequently spoil their joints by paring so that the sockets are similar in shape to what is shown by the sectional view at Fig. 39, and, consequently, when they force the two parts together they obtain a result similar to Figs. 40 and 41, causing not only bad fitting of the shoulders and other parts, but also, frequently, splitting at the front by the excessive pressure against the half-pins. Having finished the sockets between the pins, the pin piece should be adjusted on the side piece, and the shape of the pins marked on to the side piece as shown in Fig. 42. Then the sockets can be sawn and mortised and pared in the waste, similarly to the box dovetail described in an earlier chapter. An alternative method is to set out and make the sockets in the side piece, and then adjust it on the

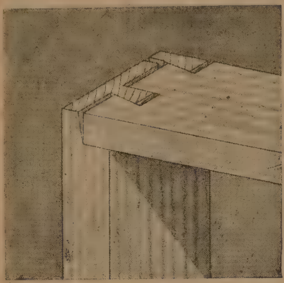


Fig. 38.—Paring to Produce Good Fit (Exaggerated)

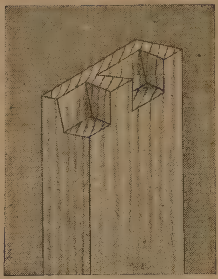


Fig. 39.—Common and Faulty Method of Paring

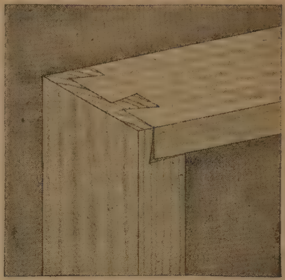


Fig. 40.—Bad Fitting and Splitting

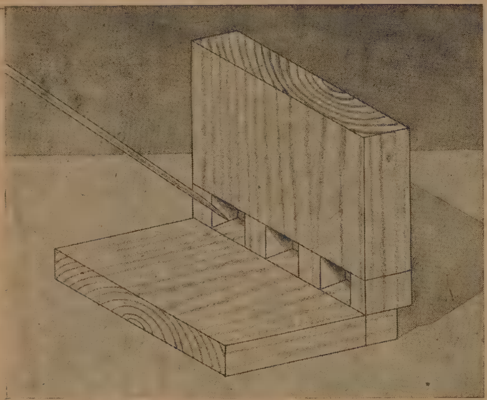


Fig. 42.—Marking Sockets from Pins

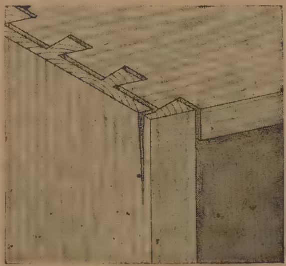


Fig. 41.—Bad Fitting and Splitting

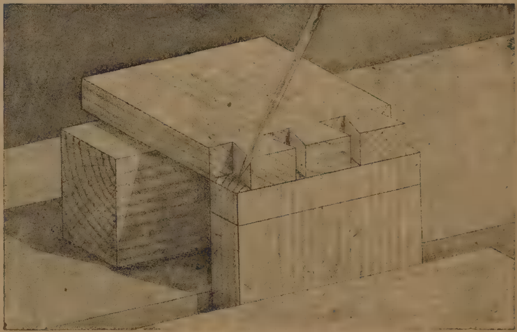


Fig. 43.—Marking Pins from Sockets

front piece and mark out the pins from the sockets as shown by Fig. 43, this being somewhat similar to the alternative method of making the box dovetail joint described on an earlier page.

Secret Lap Dovetail Joint.—Fig. 44 shows a secret lap dovetail joint, Fig. 45 showing the same joint when the parts are separated and viewed from the outer surfaces. Fig. 46 shows the inner surfaces and a more general view of the jointing. As will be seen, one part of the joint has a projecting fillet or lap piece which, when the joint is finished, is often rounded off, especially when used for the angles of boxes, cabinet cases, plinths, etc. As,

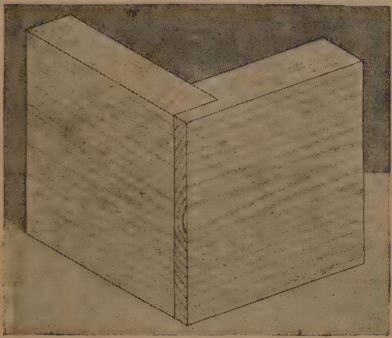


Fig. 44.—Secret Lap Dovetail Joint

of course, the making of this kind of joint is similar in many respects to the work previously described, only new features need now be dealt with.

The setting out of the rebated end is shown in Fig. 47. After this process, the waste piece should be sawn out a little from the scribed lines and gauge line, and then planed with a rebate plane or shoulder plane exactly to the lines, when the end of the piece will appear as shown in Fig. 48. The other piece will simply be square ended and have a shoulder line across its inner surface equal to the distance it is to enter the rebated piece. The pin piece is then set out as shown at Fig. 49. As there illustrated, the ends of the pins can readily be set out to the proper angle by using a thin piece of wood or zinc cut to the required shape.

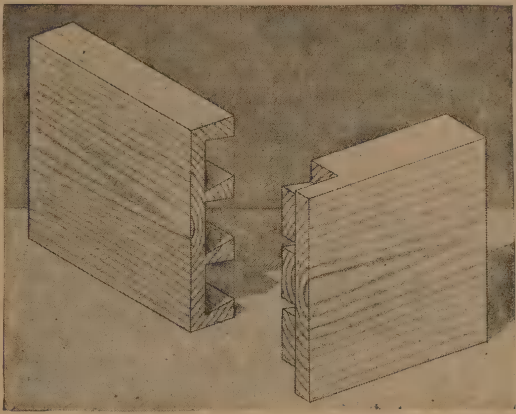


Fig. 45.—Secret Dovetail: Pins on Square End

The pin piece is next placed on the socket piece and the sockets set out as shown in Fig. 50. In this joint it will be seen that the pins of the dovetailing are made on the rebated piece and the sockets are made on the square-ended piece (see Figs. 51 and 52); whereas in

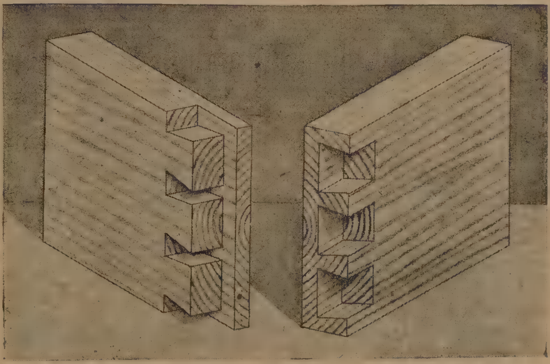


Fig. 46.—Secret Dovetail: Pins on Square End (Inner View)

the case shown by Figs. 45 and 46 the pins are made on the square-ended piece and the sockets on the rebated piece. The principal point with regard to this is that in this and almost all kinds of dovetailing

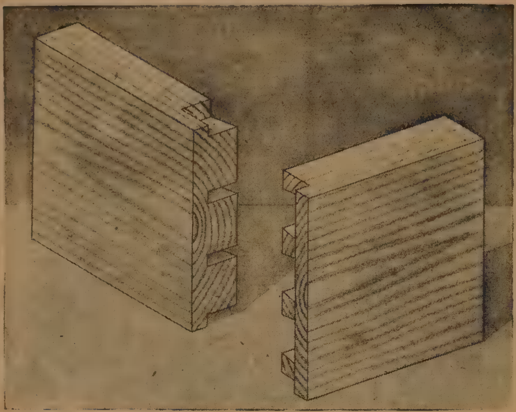


Fig. 51.—Secret Lap Dovetail Joint Apart

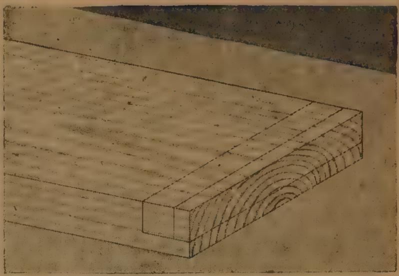


Fig. 47.—End Set Out for Secret Dovetailing

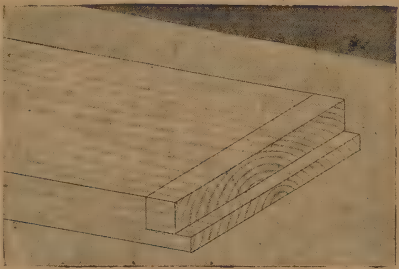


Fig. 48.—End Rebated

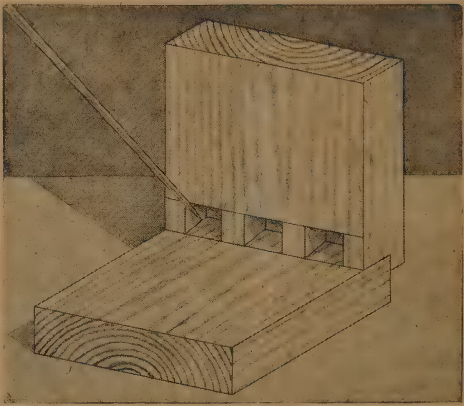


Fig. 50.—Marking Sockets of Secret Dovetail from Pins

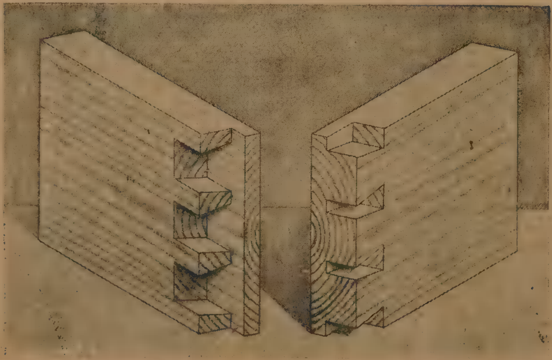


Fig. 52.—Secret Lap Dovetail Joint Apart (Inside View)

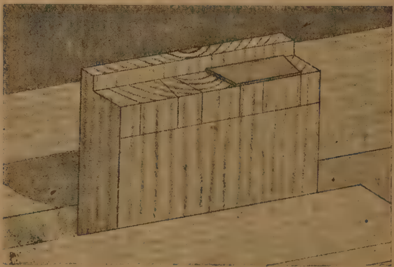


Fig. 49.—Setting Out Pins of Secret Dovetail

the sides against which the greatest pressure is likely to be exerted should contain the pins, because if the joint is properly made the greater the pressure (of course, within reason) the tighter the pins would be in the sockets, whereas if much pressure is exerted against the socket piece, the pins simply tend to slide out of joint. Fig. 54 shows the parts separated. In Fig. 54 the dovetailing is formed by having a pin near each edge, whereas in the joint shown by Fig. 55 the pins proper are at some distance from each edge. Both methods are used, but the writer considers that the joint illustrated by Fig. 54 is the stronger.

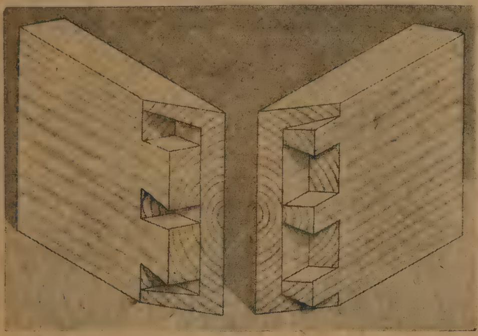


Fig. 54.—Secret Mitred Dovetail Joint Apart

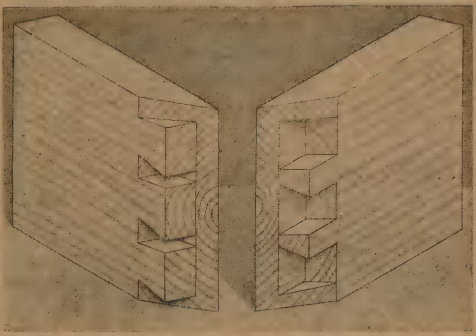


Fig. 55.—Pins at a Distance from Edges

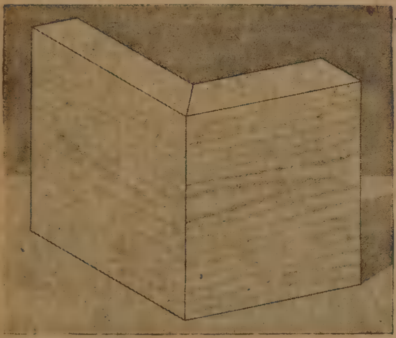


Fig. 53.—Secret Mitred Dovetail Joint Together

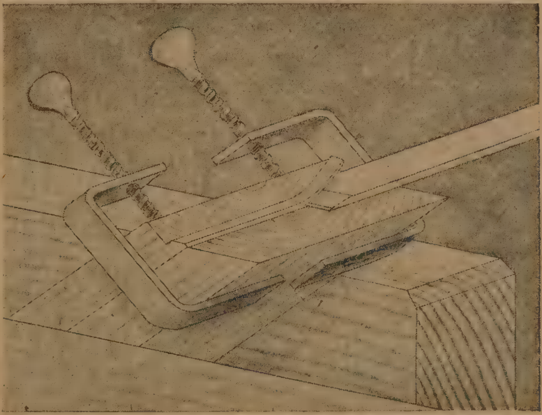


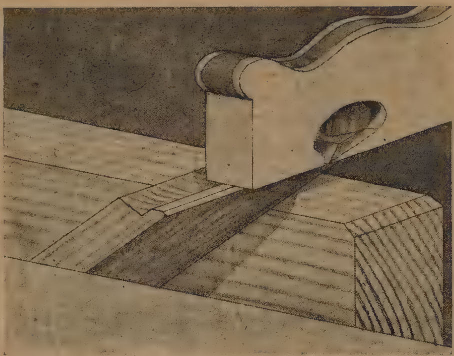
Fig. 56.—Paring the Mitre

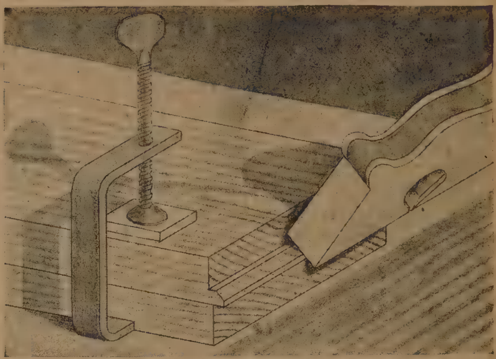
the sockets. In this and the secret mitred dovetail which follows, it will be noticed that it is almost imperative to make the pins first and mark the sockets from them, because it would be difficult and clumsy to reverse the process.

Secret Mitred Dovetail Joint.—Fig. 53 is a general view of this kind of

In setting out this kind of joint, both pieces forming it must have their ends set out, rebated and made similar to what is shown at Figs. 47 and 48. The mitres may now be nearly made. These can be pared with a long paring chisel, a wide one being preferable; then, if a piece of wood about 1 in. thick be planed at one

end to the true angle, and the work adjusted and cramped to this, and next the whole firmly fixed in the bench-screw, the mitre can be easily and truly pared, the work and preparing the mitres by using a metal shoulder or rebate plane, either of which will probably be found more suitable for the amateur than using





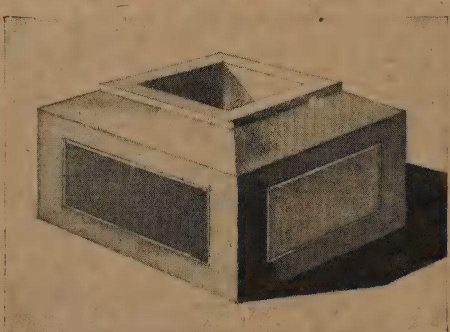
Figs. 57 and 58.—Secret Mitred Dovetail: Planing the Mitre

as indicated in Fig. 56. Of course, an expert might do without this aid, although if there were a number of joints to do he would find it more expeditious. Figs. 57 and 58 show two methods of holding the chisel alone. In any case a slight amount should be left for final easing and fitting of the mitre. The pins should next be set out and made, and the sockets made from these in the usual way.

A Safety Inkstand

For making the inkstand shown, use a block of well-seasoned hard wood of a size to suit the particular inkpot.

Finish the block smooth and square, and neatly gouge out the square sinking to suit the glass inkwell, finishing the sides with a chisel. Next chamfer the top edges, leaving a tiny vertical fillet all round at the top as here illustrated. The two sides cutting across the grain should be worked last. It is advisable to cement a piece of lead in the bottom of the sinking, or, alternatively, the sinking might be taken right through the block and a small sheet of lead recessed into it from below, afterwards covering by gluing on the bottom a piece of felt or baize. Without the lead the inkstand is too easily upset.



A Safety Inkstand

Repairing Pocket-knives and Pen-knives

SPRING-KNIVES are usually called pocket-knives or pen-knives. A pocket-knife is of stronger make, with the blades at one end only, whilst a pen-knife is a lighter-made knife, with one blade or more at each end.

For the proper execution of knife repairs certain special tools and implements are necessary, these including a cutler's stithy, glazers, etc., which are described elsewhere in these volumes.

Grinding Blades.—A worn or snipped blade must first be set in at the shoulder, as shown in Fig. 1, with a triangular saw-file, and the edge straightened on the grindstone before grinding the flat sides of the blade. When grinding to a thin edge, repeatedly dip the blade in water, if using an emery-wheel; otherwise it will become so hot as to "draw the temper" and become soft. Next rough-glaze, then finish on a fine glazer, putting on a good colour by rubbing a smooth pebble across the glazer.

Making a Fine Glazer.—To make a good fine glazer use a rough (or newly dressed) glazer that has been slightly worn down, and rub some tallow or mutton suet well into the surface, then some emery cake, or compo, which can be bought ready-made. This compo can be made by putting 2 parts of mutton suet and 1 part of beeswax in an old iron saucepan; when melted, stir into it as much flour emery as it will absorb, then pour on a board previously covered with flour emery to prevent the mixture sticking to the board. When nearly cold, mark across in squares, which will easily break when quite cold. To preserve the fine glazer in good condition, keep it well charged with mutton suet, emery cake, and beeswax.

Whetting Blades.—To whet a knife blade, first dip its point in sweet or olive oil, and then draw its edge across the whetstone (holding it to the edge at an angle of about 45°) in sharp successive strokes from pinch to point, first one side and then another, until the edge bites when tried with the thumb.

Re-blading a Knife.—To re-blade a pocket-knife, insert an old blade between the tang and the bolster, cut through the pin by striking with the hammer, and remove the blade. Next place the tang between the cut pin and the bolster, when a smart tap with the hammer will force the pin out at one side. This being removed, punch out the remaining portion of the pin with a steel point. Should the above method fail, the pin must be drilled out.

Knives with pearl scales—or "pearl-handle" knives, as they are often called—must have the head of the pin reamed off; the pin is then punched out very carefully with a thin steel punch or point, or drilled out completely, as pearl scales, being very brittle, are liable to break if treated in the same way as bolstered knives. This applies to all knives not

having bolsters, except those with nickel or other metal scales.

The old blade having been removed, a steel or iron drilling plate (see Fig. 2) should be secured to the edge of a bench.

Fig. 1.—Setting in a Worn Blade

Select a new knife-blade of the proper size and thickness, place the old tang over the new one, so that it covers correctly, and screw in the vice; then mark the new blade through the hole in the old one with a drill. Take them out of the vice, and drill the hole through. Then knock a pin through both tangs, re-fasten them in a vice, and square the new blade to the old one. When the blade has been made to fit properly, smooth-file and burnish square the front and back, glaze the end and flat side, ream or countersink the holes in the bolster slightly, and rivet the blade in position. It is advisable to insert a thin piece of steel, shaped as shown at Fig. 3 (the thin end of an old table-knife blade, with notch filed in the end, will do), on that side of the blade to which it is required to fall, so that when the piece is removed the blade falls in the proper direction.

To re-blade a knife the old blade of which is missing, try a blade as near

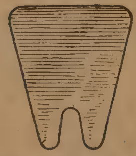


Fig. 3.—Thin Steel Wedge for Guiding Fall of Blade

the size as can be judged, and if it is a fairly good fit, square the new blade to it. To judge whether a blade fits in the knife properly, see that the spring stands square with the scales when closed and when fully opened, and does not sink under or stand out from the scales.

Repairing Two-blade and Three-blade Knives.—In repairing two-blade pocket-knives, see that the small blade, when open, stands straight with the large one, and, when closed, that the nail

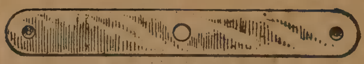


Fig. 2.—Drilling Plate

grooves are clear of each other. In two- and three-blade pen-knives it is usual to put in the small blades first, especially when they are fitted with a small brass plate (see B, Fig. 4) at the small-blade end to ensure the large blade clearing the others. If one blade falls to the wrong side, and so fails to clear the other, take it out, and, placing a thin piece of metal under the tang, lay it on the stithy; then a smart tap with the flat hammer just in front of or across the hole will probably have the desired effect.

When the Blades do not Shut Properly.—If the point of a new blade sticks up, file a little off the kick (indicated at C in Fig. 1). If the point is too low, a few taps with the hammer in the same place will raise it. Of course, all these little alterations should be made when trying the blade in the knife, before riveting.

Sometimes the raised point of a blade will not shut down at all. If dirt is

Fig. 4.—Pen-knife with Brass Plate for Separating Blades

not ledged between the tang and the spring it will invariably be found that the want of oil on the tang end has set up friction and caused a hollow to form in the end of the spring, wearing the end of the tang away, and so causing the point to stick up. In that case, if the

hole in the spring is too deep, a new spring must be provided, with the end left a little broader, to correspond with the amount worn off at the end of the tang. If the hollow is not too deep, and the spring end will allow it, file the whole nearly out; then hammer the spring a little broader. This will make it longer and thinner as well, and the blade tang also will require flattening out. If the blade, when tried, stands too forward, take it out and file a little off the spring end; this will let back the blade.

Fixing New Scale or Covering.—For this purpose take the knife to pieces, and, placing the new scale on the brass lining, see that it covers all over. Place it in the vice, and drill through the holes in the lining, pressing at the back with a piece of wood, to prevent a piece being

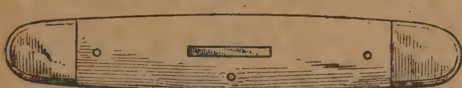


Fig. 5.—Double-bolstered Knife

chipped out of the scale when the drill slips through.

A bolstered knife, such as that shown at Fig. 5, must have the covering matched so as to fit close. If there is a bolster at each end, as shown, the ivory or other covering must first be filed slightly slanting and hollowed at one end to fit up to the bolster. Then mark the other end; if much too long, saw off the surplus, and file as before, taking care that the scale fits in rather tight. Then proceed to drill the holes.

Pearl scales must have holes slightly larger than the lining, for if the wire is tight such scales are liable to break. All holes must be reamed a little on the outside, to allow for the pin spreading when riveted. After putting on the scale and filing to shape, take out all the file marks with No. $1\frac{1}{2}$ emery-cloth, finishing with flour emery-cloth, this method being the most convenient for repairers; then rub on some oil, and dip in powdered pumice-stone or fine sand, and buff or dolly off until a bright surface is obtained.

Repairing Broken Scale.—When a new piece is required to be fitted to a broken pearl or ivory scale, saw the end of the broken scale straight, drill one or two small holes, about $\frac{1}{8}$ in. or $\frac{3}{16}$ in.

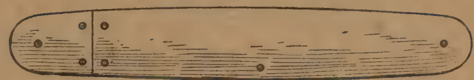


Fig. 6.—Repairing Broken Scale

(according to the size of the knife) from the edge, through both the covering and the brass scale, and pin them together. Now fit on the new piece and pin in the same way (see Fig. 6). Drill the hole for the blade pin last (if there is no bolster), as the piece may move if not held properly, and thus break when the blade is pinned in, as the hole will not be true.

Inserting New Spring.—To insert a new spring, take one in the rough state, as near like the pattern as possible, and mark through the holes in the broken spring; then drill the holes through on the edge of the bench, taking care to make the holes straight. Give the proper amount of bend (see Fig. 7) whilst soft, and file up; then heat in the fire to cherry red, and plunge in water or oil. Clean a portion with emery-paper so that the temper can be ascertained, and, smearing with tallow or oil, hold it over a clear fire. When the grease is burnt off, the spring will usually be found sufficiently tempered and of a good blue colour. Try it with a file, as it is important that it should be of the right temper; it should just show the marks of the file. If it is too hard, it will break; and

Fig. 7.—Bent Spring

if too soft, it will be too weak, and the blade will not shut with a click. When properly tempered, brighten the spring, if required; the end where the tang works must always have the black taken out, to enable it to work smoothly.

Miniature Electric Lighting: The Batteries, etc.

ALMOST every amateur has at some time considered the purchase and installation of a miniature electric light set, but as yet no system which can provide a moderate amount of light can be called really economical. Either the candle-power derived from a set has been low, or else, where higher candle-power has been obtained, the cost has been considerably increased. There is need for a new primary battery which will supply a good volume of current at a small cost.

BATTERIES

The cell or battery is the most important consideration in the erection of a miniature installation. Improvements have been made both in fittings and wires which leave these altogether out of serious consideration, but not much has been done to improve the capabilities of the various kinds of cells used for the purpose. Many improved cells have been placed on the market, but the greater efficiency concerns chiefly the lasting powers of the cells, and does not mean increased amperage or volume of current, which, as will be shown later, is the chief consideration. The choice really rests between wet cells and accumulators (secondary batteries), though in some cases, where portability and cleanliness are particularly desired, dry batteries are found very useful.

The following are descriptions of the best-known types of cells at present in use.

Leclanché Cell.—These cells (Fig. 1) are unsuitable for electric lighting. Three of them are required to light a 4-volt lamp of 2 candle-power only, and for no more than from ten to twenty minutes will this amount of light be derivable. In cases where a light is required for only a few seconds, for looking at the clock at night, or for using a lamp as any kind of signal, these batteries will suffice; but for continuous electric lighting they are out of the question. Their voltage, electro-motive-force (E.M.F.), or pushing power is 1·6 volts; their amperage varies from about 1 in the 1-pt. size to about 2 in the 3-pt. size.

A Leclanché cell comprises a glass jar in which stands a porous pot containing a carbon plate packed in with a mixture of granulated peroxide of manganese and carbon, the pot being sealed with bitumen, in which are two small holes for the escape of gas. Standing in the jar outside the porous pot is an amalgamated (mercury-coated) zinc rod. The liquid in the jar is a solution of sal-ammoniac in rainwater.

Sack Leclanché Cell.—These cells (Figs. 2 and 3) are practically the same as the ordinary Leclanché cell, except that the mixture around the carbon rod is enclosed in a canvas bag instead of being in a porous pot, the liquid thus reaching the mixture around the rod more easily. As in the case of ordinary Leclanché cells, three are required to light a 4-volt lamp

of 2 candle-power. The advantages of this type of cell are its fairly cheap initial cost and cheap upkeep, its simplicity in construction, and inexpensive renewal. Of its disadvantages the following are probably the most important: first, the small candle-power (consequent from the low amperage), unless a fairly good number of cells is employed; then the large amount of room taken up by any fair number of cells, and the fact that after about one hour's time the light diminishes and the cells need to be allowed a short time to recuperate before more light can be obtained. Their E.M.F. is 1·6; in a large cell (9 in. high by 5¼ in. in diameter), the amperage is said to be as high as 16, but the cell soon needs an interval for rest. Recently, however, various improved forms of sack Leclanché cells have been placed on the market, and one which the writer has found to be worthy of particular mention is the "Economic" light cell.

Bichromate Cell.—Batteries coming under this heading may be either the single-fluid type (Figs. 4 and 5), comprising two carbon rods and one zinc rod immersed in a solution of bichromate of potash (diluted) and sulphuric acid, a double-fluid type such as the Fuller (Fig. 6), or, as in some cases, a form of dry battery, but composed of the same materials as the fluid bichromate. This cell has the advantage of a strong current and a higher voltage than many of the other wet cells usually employed in lighting, but the ordinary cells are suitable only for intermittent lighting. For working model railways and trams, the running of motors, energising shocking coils, etc., where the cell need not be left for any length of time, it generally suffices. The zinc rod in a bichromate cell has to be placed in or out of the acid by means of a rod attached to it, and this acts as a kind of switch, for when the rod is in the acid current is given off, and the rod need only be lifted clear of the acid to stop the flow of current. Thus it will be seen that a battery of bichromate cells must be in an easily accessible position to adjust the zinc rods for starting and stopping the flow of current. Another feature of this cell is the variation in the current given off. The action of the acid on the zinc rod soon eats it away unless it is well amalgamated with mercury, and to restore the lost proportion of current it is often necessary to push the zinc rods farther down into the acid. Where three or more cells are employed, the cost of recharging and supplying with new zinc rods is considerable in proportion to the amount of light obtained. The E.M.F. is 2 volts.

The ordinary single-fluid bichromate cell has a zinc plate between carbon plates dipping into a solution made by dissolving 3 oz. of bichromate of potash in 1 pt. of hot rainwater, cooling, and adding 3 oz. of sulphuric acid.

Dry Batteries.—This form of battery is used in portable lamps, bicycle lamps, table and desk fittings, pocket flash lamps, etc., which necessitate a clean cell which can be used in any position. Their cost is not very great initially, but when once exhausted they cannot conveniently be recharged and new complete cells have to be obtained. Their voltage and amperage on discharge are identical with that of the Leclanché cell.

Many dry cells are on the market for use in some of the above-mentioned ways which yield 4 volts instead of the usual 1·6 given off by single dry cells. The reason for this is that these cells are really a set of three separate and distinct zinc-cased cells (Fig. 7) coupled together to form a battery, enclosed in a paper or similar covering (see a later part of this chapter). Their theoretical voltage is 4·8. Many cells of this description are sold under well-known trade names, and are very suitable for use where space is limited. In the case of a table reading lamp, for instance, wet cells would occupy too much room, as also would three single dry cells, and the only remaining methods are those of using this form of 4-volt dry battery lighting or by means of an accumulator. Should the dry battery method be selected, a table reading lamp (costing a few shillings or a few pounds), may be screwed on to the top of a wooden box, the dry battery being placed inside. One

Fig. 1.—Leclanché Cell

Fig. 2.—Cylindrical-zinc Sack Leclanché Cell

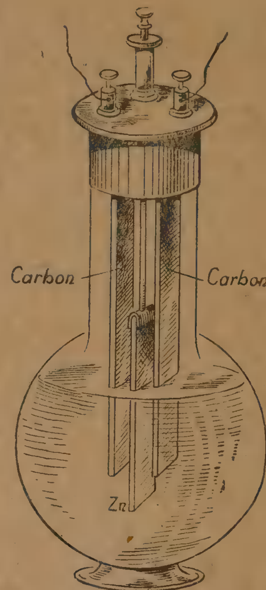


Fig. 4.—Bottle Bichromate Cell

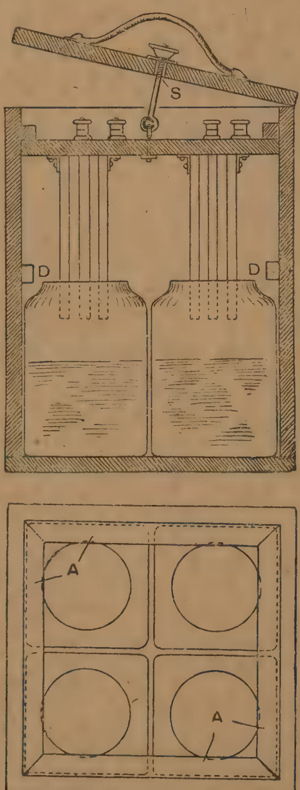


Fig. 5.—Vertical Section and Plan of Portable Leclanché Battery

Fig. 7.—Plan of Dry Battery

Fig. 3.—"Sack" of Leclanché Cell

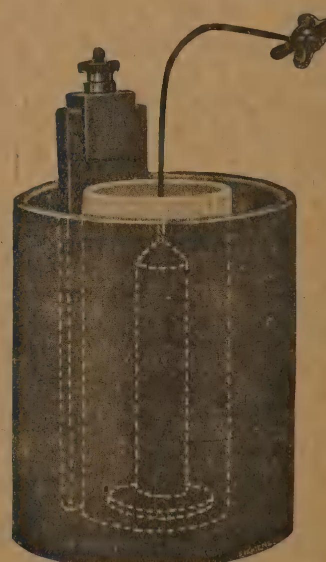


Fig. 6.—The Fuller Double-fluid Bichromate Cell

wire is taken direct from one of the battery terminals up to the lamp socket, and the other is brought back again to a switch fixed on to the side, and thence up to the lamp socket. No matter how many cells are employed, the candle-power obtainable from them will not exceed half the combined voltage. Thus if three cells be coupled together, to give, say, 4½ volts, only 2 candle-power can be safely taken from them; and were it desirable to have, say, a 12-candle-power lamp or two lamps of 6 candle-power each, from fifteen to eighteen cells might be necessary to supply the current. Perhaps a slightly higher candle-power than twelve could be obtained from this number of cells, but how long that amount of light would be kept constant it would not be safe to say.

ACCUMULATORS OR SECONDARY BATTERIES

For all the purposes previously mentioned and for all kinds of miniature lighting, the accumulator or secondary battery is not only suitable, but in the majority of cases the best, even though the initial cost is rather heavy. An accumulator gives a much higher amperage than a primary battery, and as a result higher candle-power. The voltage of a fully-charged accumulator is slightly more than that of a good primary battery, about 2 to 2·5 volts, but it is customary to connect two or more accumulator cells together to form a battery of which the voltage is at least 4 volts.

The space occupied by an accumulator is also small as compared with primary batteries. The following table shows at a glance the relative candle-powers which may be obtained from accumulators of various sizes:—

Voltage	*Ampere Hour Capacity*	*Maximum c.p. Safely Obtainable*	*No. of Hours at Maximum*
4	5	2	10
4	10	4	10
4	20	8	10
4	40	16	10
4	100	40	10

This table is based on the use of metal filament lamps, and in all cases the maximum candle-power can be decreased and the number of hours increased proportionately, the product of the candle-power multiplied by the number of hours remaining the same. The maximum discharge of an accumulator is always reckoned at one-tenth of its ampere-hour capacity, as the table shows when the maximum candle-power column is divided by four. In miniature electric lamps of the metal filament type, 4 candle-power for every one ampere of current can be obtained, using a 4-volt accumulator; in other words, one watt (volts multiplied by amperes) = 1 candle-power.

Another good point is that accumulators maintain their high amperage on discharge until almost the last—that is, until the voltage drops to about 3·5, which is the lowest point to which they should be allowed to fall, and at this stage they are ready for a further charge. With careful use, the only cost in the upkeep of an accumulator will be that of recharging, but if the person possessing it is in a position to charge it himself this cost will be very small. Precautions to take with accumulators will be stated in due course.

By means of a material called glass-wool an accumulator can be rendered unspillable and thus used for portable purposes in any capacity in which dry batteries are used. The glass-wool is wrapped all round and between the plates of the cell before sealing up the lid; and, previous to charging up, the cell is filled with acid and emptied out again after the charge is completed, the glass-wool absorbing all superfluous acid. Glass-wool can be bought from any electrical goods dealer.

LAMPS AND FITTINGS

Lamps.—Suggestions and recommendations will now be given with regard to the choice of fittings and lamps. Carbon filament lamps should for general purposes be left out altogether. They not only give little light, but simply "eat" up the current in comparison with metal filament lamps, and these are manufactured and

sold so largely that they have become moderately low in price. The metal filament has now been very much strengthened to withstand vibration, and may now be used on tram-cars and trains, motor-cars, and other vehicles. Supported filaments are recommended even if required for stationary use alone; they are ensured against breakage by jolts or accidental knocks. Fig. 8 shows the unsupported filament and Figs. 9 to 12 supported filaments. Figs. 9 and 11 are "Osram" bulbs, which can be recommended for all purposes. Fig. 9 is suitable for any kind of stationary use where vibration is likely to occur; but for use on cycles, motor-cars, etc., the lamp shown by Fig. 11 is recommended; the bulb shown is of 4-volt 4 candle-power, and in the 8 candle-power type two separate filament coils are arranged side by side. Fig. 10 is also an 8 candle-power lamp, though not of the Osram make. A particular advantage in purchasing 8 candle-power lamps with two filaments arranged in parallel is that should one break the other remains alight, giving off 4 candle-power.

Another moderate priced bulb is that shown in Fig. 13, this being of 4 candle-power and having the support midway between the filament strands and on one side of them. Fig. 12 shows a high-candle-power focus bulb for motor head-lights, lanterns, and wherever a concentrated light is required. The filaments in this type are arranged in a bunch, thereby centring all the light. It will be observed that the lamp shown in Figs. 11 and 12 are pipless, this having the advantage of minimising the risk of the seal becoming broken by a knock. Once the partial vacuum is destroyed the lamp becomes useless.

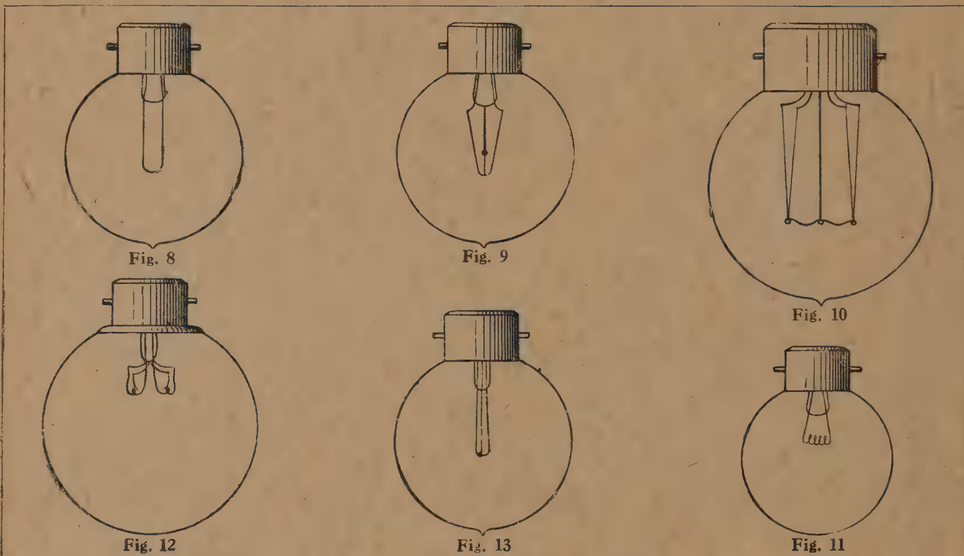


Fig. 8 Fig. 9 Fig. 10 Fig. 12 Fig. 13 Fig. 11

Figs. 8 to 13.—Various Forms of Metallic Filament Lamps

Lamps from 2 to 8 volts of various candle-power sizes can also be bought, if desired, fitted with the miniature screw instead of with the small bayonet cap; but special holders will be required for these. Electrical dealers' catalogues should be perused before deciding on a purchase.

Fittings.—For all the lamps already illustrated the small bayonet cap holder is suitable. A shade carrier is usually fitted on these which allows of a variety of shades and reflectors to be used as desired. In ordering lamp-holders, unless

they can be personally inspected before purchasing, it is wise to see that they are fitted with cord grips, a further protection for the whole fitting in case of a fusing of the wires at the ceiling rose. The batten holder shown in Fig. 14 comprises the ordinary small bayonet cap-holder fitted with a plate at the back drilled with two or three holes for screws; this type is very handy for screwing on walls, ceilings of huts, and in similar places. Fig. 15 shows a useful combination adapter by which means a small bayonet cap-holder may be made to take a miniature screw bulb. The portion A is fitted in the socket of the lamp-holder and the part B is fitted with a thread to take a screw lamp. Many types of holders for portable lamps, etc., are obtainable.

In a miniature installation it is sometimes advisable to insert in one or more places in the circuit a plug for tapping current to be used for motors and experimental purposes. An ebonite two-pin plug is perhaps the best for this purpose, and one can be obtained very cheaply.

With reference to switches, not much need be said except that for hand lamps, table lamps, and similar purposes switches which are too large and clumsy should not be used, as such a variety of small switches (see Fig. 16) are easily and cheaply obtained. A large switch on a portable set is very unsightly. Where an accumulator-lighting installation is erected and managed with care fuses are not essential; but when they are used place them as near as possible to the accumulator (they are quite unnecessary with primary batteries). Two small terminals screwed into a wooden base form a good fuse holder. In purchasing fuse wire it is advisable to state the voltage, number of lamps and candle-power.

WIRING

For ordinary uses in miniature lighting, electric bell wire will be found suitable. It is not thought necessary here to give any table of the current-carrying capacity of various sizes of wires, but when an installation is to be fitted up which is to carry more than three or four amperes of current used continuously, the wires selected should not be smaller than No. 14 S.W.G. Where lamps are to be suspended from the ceiling, miniature flexible wire of a suitable colour of covering is the best to use.

Wires of good quality are always the best to use. The cheapest wires are generally only covered with one or two layers of cotton, paraffin waxed, whilst those of better quality are insulated with silk or rubber.

VARIOUS APPLICATIONS OF MINIATURE LIGHTING

Desk Light.—The desk light about to be described is of simple construction. The writer used an old gas bracket for

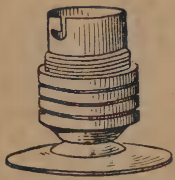


Fig. 14.—Batten Lamp-holder

Fig. 16.—Miniature Turn Switch

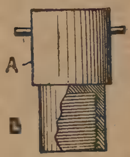


Fig. 15.—Combination Adapter

the main support, as shown by Fig. 17. To the collar A is attached a short length of brass gas tubing, and the end B, being ready tapped, is fitted with a washer (the purpose of this will be shown later). Various forms of reflectors may be used; the one shown by Fig. 18 is suitable, and can be bought for less than 2s. This reflector is fastened to a round piece of cigar-box wood with a few small screws; and a piece of sheet iron $3\frac{1}{4}$ in. long and about 1 in. wide is bent as shown by Fig. 19. A hole to admit the end of the pipe (B, Fig. 17) is drilled at A, and two smaller ones for screws, as shown at B. This piece of iron is screwed to the back of the reflector, and a piece of thin sheet brass $1\frac{1}{2}$ in. long and $\frac{1}{2}$ in. wide is also screwed to the back in the position indicated at A in Fig. 20, which shows the complete stand in position when not in use. This forms the centre contact for

the screw lamp. The other contact is made by fastening one wire to the tin reflector in any way that may be convenient.

To assemble the parts, run two wires through the bracket, attaching one to the centre contact screw, and the other to the reflector, and put the end of the bracket B (Fig. 17) through the hole in the iron attached to the reflector, afterwards screwing on the washer from the under-side. The switch is fixed to a piece of wood rounded off at the top; the bracket is fastened to the same piece by a staple driven in from the side. Two screws through B fasten the contrivance to any desk or writing-table, and by means of the swivel action it is very easily turned out of the way when not required.

Cycle Lamp.—To the cyclist who has become tired of the oil and acetylene lamps, and who wishes to furnish his bicycle with electric light, but cannot afford, or does not care for, a wheel-driven dynamo, the following information will especially appeal. A complete outfit, including accumulator, may be purchased for about a pound or so, or with a dry battery in place of the accumulator this cost is reduced considerably; yet dry cells are costly to replace when once exhausted. A cyclist who already possesses an oil lamp may convert it into an electric lamp cheaply by following the instructions here given.

Take the oilcan out of an ordinary cycle lamp, and cut a piece of cigar-box wood to fit tightly into the slots from which the oilcan has been withdrawn. Next bore a hole in the centre of this piece $\frac{5}{8}$ in. in diameter. Obtain a small bayonet cap lamp-holder, and unscrew the shade carrier from this. Push the holder through the hole from the under-side, and then screw the shade carrier on again from the top. This will keep the lamp-holder securely in its place as shown in Fig. 21, and slide the piece of wood with the bulb in its socket into the lamp, which is now complete.

Thus it will be seen that at the expense of a lamp and lamp-holder, an old oil-lamp is converted into an efficient electric bicycle lamp. An accumulator costing a few shillings will provide the necessary current, and should give a very good light using a 1-ampere, 4 candle-power metal-filament lamp for about six or eight hours at one charge. This can be carried on the cross bar either in a leather case, such as are sold for the purpose, or a small wooden box. The switch may be fastened to any part of the frame.

Piano Lights.—To replace the little-used candles on a piano with clean, efficient electric lamps is not difficult. By the following method miniature electric lamps may be fixed on to a piano without screwing into the face-side of the woodwork. A small bayonet-cap lampholder can generally be made to fit snugly into the cup of a piano candlestick, as shown in Fig. 22. The lamp-holder is wired with silk flexible wire of colour to match that of the piano, and the wire is merely turned back again up the side of the holder as at A. This should now fit tightly into the candlestick, or, if a little slack, some paper may be used for packing. Two shell reflectors are next fixed on to the lamp-holders, as at B (Fig. 23). Two of these brackets having been completed, the piano can next be wired as shown in Fig. 24. A indicates the lamp brackets, wired in parallel, and B two ebonite miniature plugs screwed on the inside of the piano. When the front of the piano needs to be removed for tuning, cleaning, etc., the pins are simply withdrawn from the plugs, and the whole of the front can be taken off without cutting any wires. The switch and battery may be put in any convenient place; but a simple way is to lead the wires from the top of the piano down the inside and fasten the switch under the keyboard, resting the battery in a wooden box on the floor. C indicates the wires to the switch and battery. Two 4-volt 1-ampere metal-filament lamps provide sufficient light, and these lamps should have filament supports so as to withstand the vibration.

Staircase Lighting.—To wire a staircase with one miniature lamp in the ordinary way needs little or no experience;

but if the switch is fixed at the bottom of the stairs it can only be switched on or off from that point, the person wishing to use the light having no control from the top. The most convenient way is to employ the two-way switch system. For this, two ordinary one-way bell switches, as shown by Fig. 25, will suffice; one is fastened on the wall or in any other convenient place at the bottom of the staircase or passage, and the other at the top. Fig. 26 shows how the wiring is done. A and B represent the mains, C the lamp, D and E the one-way switches, and F and G the two leads, only one of which is used at a time to complete the circuit. Supposing the lever of the switch D is in the position indicated, and the lever E is also as indicated, the current from the main B flows through the switch D along the wire G to E, through which it cannot pass until the switch lever is moved to the opposite position; the current cannot pass through E whilst the lever is in the position in Fig. 26. By means of this simple device, the current may be switched on at the bottom and off at the top, or vice versa.

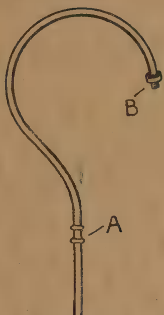


Fig. 17.—Bracket for Desk Light


Fig. 18.—Bull's-eye Reflector

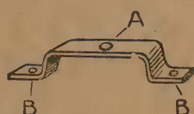


Fig. 19.—Reflector Holder

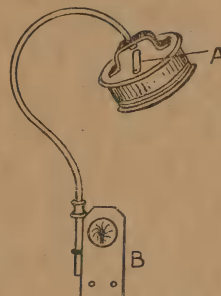


Fig. 20.—Desk Light Complete

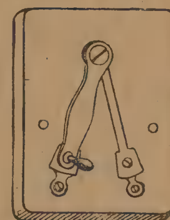


Fig. 25.—One-way Switch

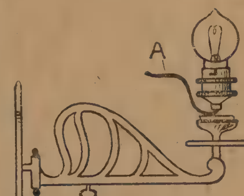


Fig. 22

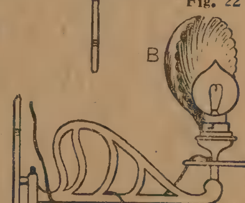


Fig. 23

Figs. 22 and 23.—Piano Brackets

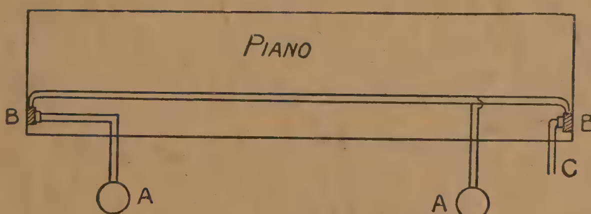


Fig. 24.—Wiring for Piano Lights

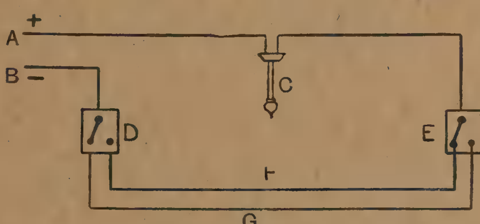


Fig. 26.—Wiring of Two-way Switch System


Fig. 21.—Cycle-lamp Holder

Bedroom Lighting.—Miniature electric lighting with a battery for a bedroom is only economical on a small scale, as over a bed or table, or in the interior of a wardrobe, etc.

To wire a bedroom for two lamps in parallel to be controlled from one switch is quite simple, as shown in Fig. 27, A indicating the lamps, B the switch, and C the battery leads. If it is desired to have two lamps, each controlled from a separate switch, the three-wire system

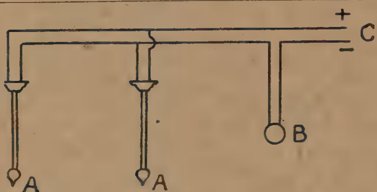


Fig. 27.—Wiring for Two Lamps Controlled from One Switch

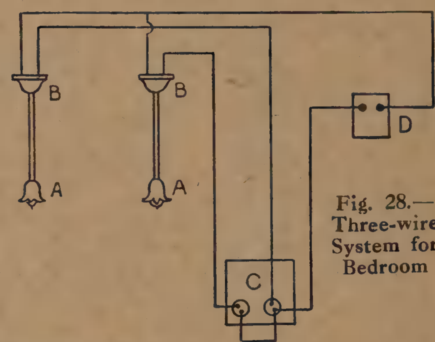


Fig. 28.—Three-wire System for Bedroom

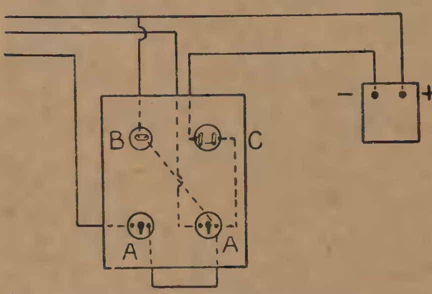


Fig. 29.—Switchboard and Wiring Connections

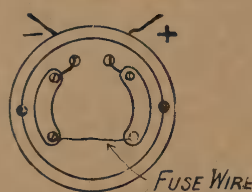


Fig. 30.—Ceiling Rose as Fuse

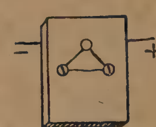


Fig. 31.—Simple Fuse

is the best, this method of wiring, as shown in Fig. 28, taking a smaller amount of wire than in running two separate circuits from the battery. Fig. 28 shows an installation by means of which each lamp (one of 4 candle-power and one of 8 candle-power) can be used independently or both together. A denotes the lamps, B the ceiling roses, C the switchboard, and D the battery. A study of the diagram will show the direction taken by the current in case of either or both lamps being used.

The switchboard shown in detail in Fig. 29 may be made from pieces of American oak or similar hardwood $\frac{1}{2}$ in. thick. A indicates the switches, B a miniature two-pin plug for use with a portable lamp or reading lamp, and C a fuse. An old porcelain ceiling rose can be used for the fuse (see Fig. 30), or if this is not at hand, two small brass terminals screwed on a square piece of wood, as in Fig. 31, will do equally well. The wiring of the switchboard is also shown by Fig. 29. For a small bedroom, two 4-volt 1-ampere metal-filament lamps giving 8 candle-power will be sufficient, or, as in the writer's case, one of the lamps may be of 8 candle-power (2 amperes).

A SIMPLE ELECTRIC HAND LAMP

The electric hand lamp here described may be made at small cost. Fig. 32 is a general view of the lamp, the case of which may be made of American oak, mahogany, or any hard wood. American oak looks very well finished with varnish or polish, stained or plain.

The wood used is $\frac{1}{4}$ in. thick, and the front is cut $5\frac{1}{2}$ in. by 4 in., and the two sides $5\frac{1}{2}$ in. by $2\frac{3}{4}$ in. The two sides may be fastened to the front either with nails or

screws; dovetailing is optional. Fix the top to the sides in the same manner. The bottom, measuring 3½ in. by 2½ in., being out of sight, may be nailed on; the heads of the nails should afterwards be punched and the holes puttied up. The top measures 4 in. by 2½ in., or ½ in. wider than the bottom, so as to fit on top of the two sides, as shown in Fig. 32. The door at the back is hinged on, and can be cut from ¼-in. wood, like the other pieces, or may be made from the lid of a cigar-box.

The bull's-eye from an old cycle lamp may be utilised for the front of the hand lamp. Cut off the lamp door as shown in Fig. 33, and cut out the centre of the front piece of wood a little larger than the size of the tin reflector from A to B in Fig. 33, and fasten this in by means of three or four small wire nails driven in from the inside of the reflector (see Fig. 34).

The bulb is a metal filament small bayonet cap, and the holder is fixed into the hand lamp by means of the contrivance shown in Fig. 35. This is composed of two pieces of cigar-box wood glued or nailed together as shown, with a hole cut in the top piece ⅝ in. in diameter. The shade carrier is then unscrewed from the holder, which is pushed through the hole from the under-side, and the shade carrier screwed down again, forming a kind of cramp to hold both the lamp and its holder in position. Fig. 36 shows the stand glued in position and a reflector placed at the back of the bulb. The piece of wood also divides the front section from that containing the accumulator or dry battery. A switch is fixed on the side, and a small brass hook and eye will keep the door fastened. The handle is fixed to the top by means of ¼-in. screws, and may be either of brass or iron.

A dry battery such as used in pocket flash lamps will provide the necessary current, if the lamp is only used intermittently for very short periods, and the bulb is only one of about ·5 ampere. But where a good light is required for any length of time, an accumulator is the best source of current. An accumulator suitable for this hand lamp may be obtained for a few shillings, and, using a 1-ampere or ·75-ampere metal filament bulb, a continuous light can be had for five or six hours at one charge.

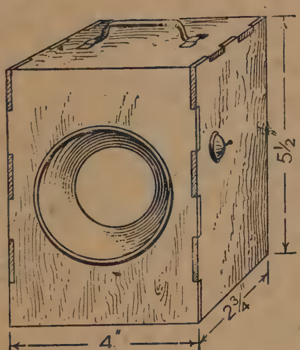


Fig. 32.—Electric Hand Lamp

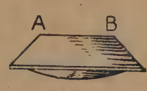


Fig. 33.—Front of Cycle Lamp

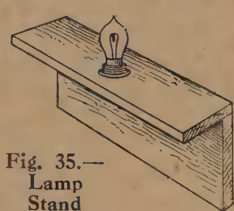


Fig. 35.—Lamp Stand or Holder

Fig. 34.—Fastening Bull's-eye to Lamp Front

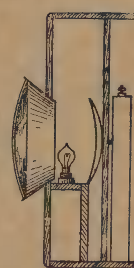


Fig. 36.—Section Through Hand Lamp

MAKING A DRY BATTERY

The rest of this chapter will be devoted to descriptions of making and maintaining certain forms of primary batteries and secondary batteries (accumulators) of interest to the amateur who wishes to instal miniature electric lights.

The first example to be considered will be a dry battery of the popular flash-lamp type.

Construction of Three-cell Battery.—It must at once be said that the home-

made flash-lamp battery is inferior to the manufacturers' product, but the following description includes the most reliable formulæ yet published and is perfectly practical in every sense. Fig. 37 is a

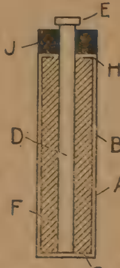


Fig. 37.—Section through Single Cell

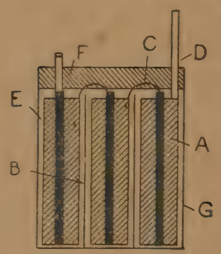


Fig. 37A.—Section through Three-cell Flash-lamp Battery

section through one cell and Fig. 37A is a section through the complete three-cell battery. In Fig. 37, A indicates a zinc cylinder lined with a blotting-paper cylinder B, in the bottom of which is a cardboard disc C. A central carbon D, having a brass cap E, stands on the disc, and is surrounded with active material F. The blotting-paper is turned in at H, and the cell is sealed with pitch at J.

In Fig. 37A, representing the complete battery, A indicates the cells, B a waxed cardboard insulator, C wire connections from zinc of one cell to carbon of the next, D brass terminals or connections, E space occupied by saw-dust, F pitch, and G a paper cover.

The Tools, etc.—The tools, etc., required include a rolling appliance (Fig. 38) consisting of a crank handle and shoulder made from odd pieces of ½-in. gas barrel, the slit A being made with a hack-saw for about 3 in. In this slit the edge of the sheet zinc is inserted, and pressure then applied to roll the metal into cylindrical form. If gas-barrel is not to hand, the rolling appliance may be a hardwood cylinder, ¾ in. in diameter, with a fine saw-cut, ⅛ in. deep, running from one end almost to the other; a cranked handle is convenient but not essential, because the containers can be neatly formed by rolling on the bench under a piece of smooth board.

A rammer may be simply a short piece of gas barrel, but a hardwood rammer ⅝ in. in diameter, bored out $\frac{5}{16}$ in. or ⅜ in., is preferable waxed and polished quite smooth.

A seaming stick will be about 6 in. long and the same diameter as the bore of the zinc cylinders, which are slipped over it for soldering.

A roller, consisting of a short piece of ¾-in. curtain rod, will serve as a former for blotting-paper cylinders, with which the zinc cylinders are lined.

The seaming-stick and blotting-paper roller need not be of hardwood and they should not be employed interchangeably, because the seaming roller will gradually become charred in use.

Brass-capped Carbons.—The brass caps for the carbons are made with the iron plate and punch shown by Fig. 39. The punch must be of exactly the same diameter as the battery carbon, but the hole through the iron plate should be $\frac{1}{16}$ in. larger in diameter. A small piece of soft brass, 26 or 28 gauge, is laid on the plate over the hole, through which it is driven with a hammer and the round-ended punch. Knock off the cap so formed, and gently drive or press the carbon into it. If the caps are made a shade too small to receive the rod ends

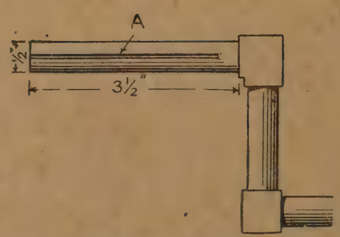


Fig. 38.—Rolling Appliance for Forming Zinc Cases

and gently heated to expand them before the latter are driven in, a very good "shrunk-on" connection results. Rings, ⅛ in. wide, cut from brass or copper tubing of suitable bore, may be substituted for caps, and shrunk on. Obtain some carbon

pencils, $\frac{3}{16}$ in. or $\frac{1}{4}$ in. thick, cut them into pieces $2\frac{1}{8}$ in. long, and fit each tightly with a brass cap. Melt some paraffin wax (or candle) in a tin until a depth of $\frac{1}{2}$ in. is obtained, and bring it almost to boiling-point. Into this insert the ends of the carbons with the caps on, and let them remain for one minute. This waxing is important, as otherwise the salts will creep up the carbon and destroy the cap.

Zinc Cases.—The cylinders consist of sheet zinc, as before stated, and this may be of the lightest gauge procurable. Cut the zinc into pieces $2\frac{5}{8}$ in. long by $2\frac{1}{8}$ in., and turn these up by means of the roller to form cylinders $2\frac{1}{8}$ in. long and $\frac{3}{4}$ in. in diameter; the pieces of zinc should be inserted about $\frac{1}{8}$ in. in the roller slit. Knock down the ridge, and solder the seam on the seaming stick, taking care that the cylinder is a tight fit, so as to ensure uniform size ($\frac{3}{4}$ in.); see also that the soldering is reliable, so that leakage is impossible. In soldering zinc, a "medium" solder (1 of tin to 1 of lead) gives good results, although 55 parts of tin to 45 parts of lead is believed to be even better. Next cut some zinc discs to fit inside the tubes thus made, about $\frac{1}{16}$ in. from the bottom, and solder from the outside.

In some brands of foreign dry cells the soldered disc-bottom is dispensed with, a layer of marine glue, about $\frac{1}{8}$ in. thick, being poured into the cylinders and allowed to set.

Lining the Cases.—Obtain a sheet of blotting-paper, and cut into pieces $7\frac{1}{4}$ in. long by $2\frac{5}{16}$ in. wide, and roll round a stick to form a treble-walled cylinder $2\frac{5}{16}$ in. high; if a superior slow-absorbing blotting paper is obtained, only two layers will be needed, the strips being 5 in. long. So arrange things that $\frac{3}{16}$ in. projects over one end of the stick. Turn in this end, and press the whole into the zinc cylinder with the stick, taking care that the blotting-paper fits tightly. Then pull out the stick. Cut a cardboard disc, and push this to the bottom of the cylinder over the botting-paper flange.

The Solutions.—Two separate solutions are required. The first one is made by mixing $2\frac{3}{4}$ oz. of sal-ammoniac, $\frac{3}{4}$ oz. of chloride of zinc, $\frac{3}{8}$ oz. of glycerine, and 7 oz. of boiled water. Stir this solution well, and pour into the paper-lined cylinders, filling to within $\frac{1}{2}$ in. of the top. Leave to soak for fifteen minutes, pour out, and up-end the cylinder on blotting-paper for one and a half hours to drain off superfluous liquid. This process supplies the excitant, and leaves the paper cylinders ready to receive the carbons and depolarising mixture.

The next process—the mixing of the depolariser—requires a different battery solution, made up as follows: 1 oz. of sal-ammoniac, 1 oz. of chloride of zinc,

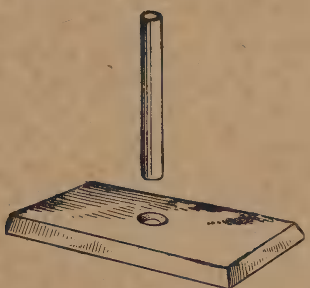


Fig. 39.—Punch and Plate for Forming Caps for Carbons

$\frac{1}{4}$ oz. of glycerine, mixed with 7 oz. of water. Stir this well, and use this to damp (only damp) $2\frac{1}{4}$ parts of powdered carbon and 1 part of manganese dioxide. To do this properly, mix the powders well. Make a hole in the centre of the powders, pour in a little liquid, mix again, and grind the lumps out with a stick.

The degree of moisture to which this black paste is mixed is a factor of the utmost importance, and on it success or failure largely depends. An accurate impression of what is required is not easy to impart by printed instructions; the word "paste" is in itself misleading, as it might be applied to describe any state or consistency of matter between those of cream and of stiff putty. The carbon and manganese mixture should be rendered to the condition of a *moist powder, crumblingly damp* rather than pasty. In this humid condition the mixture could not

be moulded in the hands, but it can be compressed or rammed into a semi-solid mass showing no elasticity or disposition to squeeze out when under pressure. It will not adhere to or clog the pestle and mortar (if such be employed). It can be loaded into the cells in small friable lumps and consolidated by gently tapping the head of the annular rammer while the latter is revolved and moved about the surface of the mixture, bringing it into compact and rigid contact with the carbon rod and moist blotting-paper separator, but without breaking through the softened fabric of the latter.

An alternative formula for the depolariser, said to produce a somewhat lower resistance and higher voltage, is given as follows :—Carbon powder, 2 parts ; plumbago or pure graphite powder, 2 parts ; manganese dioxide powder, 3 parts ; damped with a solution composed of salammoniac, 1½ oz. ; zinc chloride, 2 oz. ; glycerine, 1½ oz. ; and water, 7 oz.

Making-up.—To make a single cell, set the carbon in the centre of the cylinder, and fill half-way up with the mixture. Place the rammer over the carbon, and ram it down well by tapping with a light hammer. Then fill up again until it is within ½ in. of the top. Be careful not to break the carbon or injure or tear the blotting-paper in any way. Turn in the blotting-paper towards the carbon as shown in the section (Fig. 37), and, after doing so take care that the paper is clean on the top, and that there is no line of black mixture from zinc case to carbon pencil. If there is such a line, clean it off, or the cell will short circuit and be exhausted by the time it is required for use. This, then, is another point demanding special care and one to which attention is particularly directed. If the powder is of the proper consistency, it will be almost dry and ready for sealing over, which is done with pitch, a shallow layer of sawdust, retained by a paper disc, being first laid upon the depolarising mixture. The seal of pitch should be punctured, when set, with a heated wire to ventilate the cell.

A supply of single cells having been made, they can be connected up—that is, three cells may be assembled to form a battery, as in the section (Fig. 37A). For this purpose there will be required some No. 24 gauge wire (or bell wire) and some thin spring brass. Cut the wire into 1¼-in. lengths, the brass for the zinc connection 2½ in. by ¼ in., and for the cap connection 1¼ in. by ¼ ins. Also some partition slips of wax-soaked cardboard will be required for insulating the cells from each other, as shown at B. When the set of three cells is connected up, obtain a piece of brown paper and wrap it round the set twice, letting the paper project ½ in. from the top of the zinc. Cover over the top of the cells with sawdust (about ⅛ in.), and cover over with pitch.

To finish the battery, wrap it in a piece of black paper, allowing enough to cover over the bottom, and the cell is ready for use. Fig. 37A is a vertical section through a complete three-cell dry-battery refill.

Re-charging Dry Cells.—Dry cells cannot be re-charged cheaply and efficiently, but they may sometimes be revivified by boring a small hole in their cases and standing them in a vessel of clean water for about 24 hours. A better method is to drill a ½-in. hole through the top sealing and to pour in as much salammoniac solution as the cell will absorb. At best this only slightly lengthens the life of the cell and it is not advised.

It is possible to re-charge an exhausted dry cell in the same way that an accumulator is charged, but the effect is merely temporary, and the attempt is more or less a waste of current.

MAKING CONSTANT BICHROMATE CELLS

Fig. 40 shows in sectional view an improved form of bichromate cell (the "constant" or "double fluid" type, which owes its origin largely to Fuller, whose cell has already been illustrated in this chapter). A jar of about 7 in. by 5 in. is recommended, with a suitable porous pot and two 7-in. by 2-in. solid-top Leclanché carbons (their terminals coupled by No. 16 plain guttapercha-covered wire). Granular carbon, sifted quite free from

dust, is preferable to coke, and the top dressing of powdered coke may be omitted with advantage. A bottle-neck sunk in the top seal facilitates charging. For discharges not much exceeding 1 ampere, a rolled-zinc Leclanché rod, well amalgamated, makes a convenient positive element; but a cylinder or a couple of substantial plates are needed for outputs up to 5 amperes. A small fibre cup cemented to the end of the rod with marine glue (before amalgamation) serves to contain a reserve of mercury. Such a cell has a capacity of at least 20 ampere-hours.

For vehicle or house-boat lighting the outer jars may be dispensed with strong oak boxes divided into five pitch-lined compartments, each measuring 10 in. by 5 in., have been used to run two 9-volt 5-candle-power Swan lamps in parallel.

Several alternative solutions may be used according to the current required. For modern metallic filament lamps of low consumption there is no better formula than 5 oz. of saturated solution of bichromate of potash and 1 oz. of strong sulphuric acid for the outside jar; for the inner pot, saturated solution of ammonium chloride (sal-ammoniac). But muriatic acid (spirits of salt) may with advantage be substituted for sulphuric acid with the depolariser in the outer cell, when ammonium chloride is the excitant in the inner one. Similar results are obtained with zinc chloride in the latter; a half-saturated solution. A cheaper but slightly less effective charge consists of zinc sulphate (half saturated) with the zinc, and bichromate acidified with sulphuric acid with the carbon.

The granule cell may be forced to the limit of its power by either of the following charges: a 10-in. cell yielding 10 amperes or more at a pressure exceeding 2 volts; but extreme care and deliberation must be exercised in mixing either depolariser (for the carbon), as the heat generated by the process exceeds that of boiling water, and haste or carelessness may result in the fluid flying about with almost explosive violence. A strong and sound crock of ample dimensions must be used, and the operation conducted out of doors.

(1) Add one volume of strong sulphuric acid to one volume of cold water, very gradually and stirring constantly with a glass rod. When the heat rises to a point at which the acid hisses on contact with the mixture, stir in a quantity of bichromate crystals; these will cause some cooling off. Then add more acid drop by drop until the heat again rises to excess. Continue to stir the crystals in the mixture after all the acid is added and the liquor begins to cool off; then allow to grow quite cold before decanting into the battery. (The excess of crystals remaining in the crock may be reserved for future use.) (2) Follow the foregoing instruc-

Fig. 40.—Section Through Constant Bichromate Cell

tions, but substitute nitrate of soda for bichromate of potash. Whichever depolariser is employed, the excitant in the porous pot must be water nine volumes and sulphuric acid one volume; allow to cool before use, and keep the zinc well amalgamated.

The output of two 10-in. by 6-in. cells charged with solutions (1) or (2) may be judged by the fact that twenty-five to thirty 4-volt 0·25-ampere bulbs may be brilliantly lit by them for three or four hours consecutively; or a lesser number for a proportionately longer time. Meanwhile, of course, a considerable quantity of zinc will be consumed.

Whenever the zincs are temporarily

removed from the cells, a glass rod or other inert substance of bulk similar to the zinc should be substituted to maintain the level of the liquor in the pot, and prevent the slow infiltration (by gravity) of the outer liquid.

Amalgamating Zincs—To amalgamate battery zincs, thoroughly clean them in dilute sulphuric acid and then place them in a shallow dish (not of metal) containing mercury. With some rags or tow fastened to a stick, rub the mercury into the zinc until the latter appears clean and bright.

MAKING A SMALL ACCUMULATOR

Instructions will now be given on the construction of a home-made accumulator. The size will depend on requirements; but it is here presumed to be one of about 35-ampere-hour capacity when used for motor ignition purposes; for continuous lighting its capacity will be less.

Case.—For the case, celluloid is the best material to use; but any straight-sided glass case will do very well. The writer procured two glass cases from agglomerate Leclanché cells, such as are used in telephones, etc., the overall size of these being $5\frac{3}{4}$ in. by $3\frac{3}{4}$ in. by $1\frac{3}{4}$ in. (see Fig. 41). Should celluloid be used it will be best to ascertain the size of plates to be used, and have a case made to correspond; or if an old case is at hand, the size of the plates must be judged accordingly. Celluloid is cemented together with a cement made by dissolving shredded celluloid in sufficient amyl acetate to form a thick liquid. Keep this in a bottle well corked and away from any naked light.

The following instructions apply to the making of an accumulator from glass cases. Two glass cases will be required so as to make two 2-volt cells, which when connected up will form a 4-volt battery.

Plates.—The plates may be purchased ready pasted and formed, but the amateur may paste his own plates, which will be found quite satisfactory if instructions are carried out properly; but the lead grids had better be bought ready cast with the lugs left on. The size of the plates will be 4 in. by $3\frac{1}{2}$ in. by $\frac{1}{8}$ in. thick, and ten of these will be required, two positives and three negatives for each cell.

Pasting.—Having obtained the grids, the first step is to paste them. For the four positives, mix in an old saucer red-lead into a stiff paste with equal parts of sulphuric acid and water. The six negatives are pasted with litharge and dilute sulphuric acid of the same proportions as for the positives. Put each grid on a piece of glass, and press in the paste firmly with an old knife or wooden spatula, scraping off all excess paste with a flat piece of iron. Before using the paste let all the moisture work to the top, adding more red-lead or litharge until the paste assumes a stiff consistency. This little hint should be the means of enabling the amateur to overcome that very disappointing experience, the falling out of paste after sealing the cell. Put the plates aside to dry for about forty-eight hours.

Burning the Bridges—Three of the negative and two of the positive plates for each cell must each have their lugs connected together in some way or other. In accumulators bought complete, this is done by lead burning; and although this method is the best (the acid spray will soon eat solder away), it is very often termed as almost impossible to the amateur. The writer, however, managed to burn the lugs together satisfactorily, without the aid of any special apparatus. Proceed in the following way: Take, for instance, three of the negative plates, put them alternately with two of the positives, also fitting in the separators, which must be cut from corrugated perforated celluloid, as shown in Fig. 42, where A, B, and C are the negative plates, and D and E the positives, while the shaded portions denote the lugs. The wavy lines in between the plates indicate the separators. Having done this, bind them round firmly with string (taking care not to draw the string too tight), and cut a piece of lead about $\frac{1}{8}$ in. thick and $\frac{3}{4}$ in. wide, long enough to overlap each of the outside lugs by about $\frac{1}{8}$ in. When ordering the grids it is better to ask for long lugs; these are something similar to the one shown at A in Fig. 43;

if the plates used have square lugs, they must be cut to the shape shown. Next punch three holes in the lead strip to admit its being fitted flush with the collar on the lower part of the lugs, with the narrowed portions extending above, as in Figs. 44 and 45. Obtain a good gas blow-pipe (one may possibly be borrowed from a plumber), and after packing underneath and all round the lugs with clay, direct a good steady flame from the blow-pipe on to the extending portions of the lugs, and these will soon melt, and, running inside the clay mould, will weld together both the lugs and the lead strip. The same method is proceeded with for the positive plates, these being rather the simpler of the two.

Terminals.—Obtain four brass terminals with lead bases. These bases are usually left anything from 2 in. to 3½ in. long. Cut each one off to the required length, which can be ascertained by temporarily putting the plates in their cases, and solder one terminal on to the centre of each bridge, afterwards giving them two or three good coats of anti-sulphuric-acid paint, which will prevent corrosion by the acid spray. Soldering is here resorted to because the amateur would probably unweld some parts of his former work if he were to direct a flame from the blow-pipe on to the bridges for the purpose of burning the terminals and the bridges together; the reason is that the flame from the blow-pipe is not as fine as that of a lead-burner's apparatus.

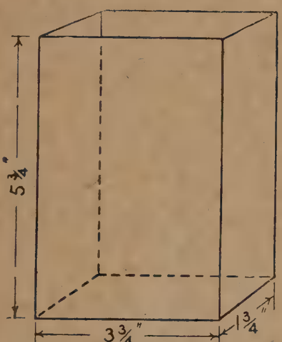


Fig. 41 —Glass Case for Accumulator

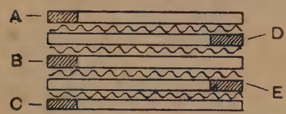


Fig. 42.—Plan of Plates and Separators

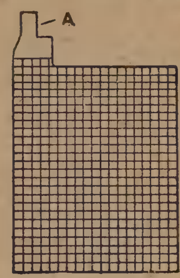


Fig. 43.—Accumulator Plate Before Pasting

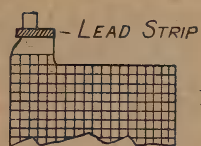


Fig. 44

Fig. 45.—Plan of Bridge

Fig. 44.—Lead Strip on Plate

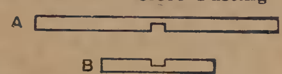


Fig. 46

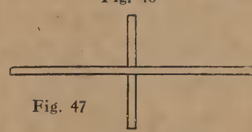
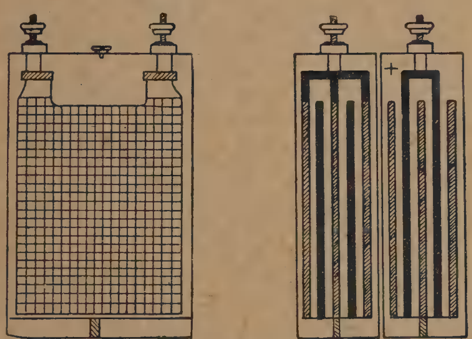


Fig. 47

Figs. 46 and 47.—Celluloid Plate Supports



Figs. 48 and 49.—Vertical Sections Through Complete Accumulator

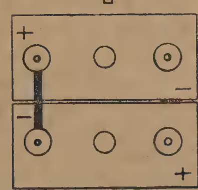


Fig. 50.—Plan of Complete Accumulator

Fitting Parts Together.—The parts, now being complete, are ready for fitting together. In order to lift the plates up from the bottom of the cases, cut two pieces of stout celluloid to the shape shown by Fig. 46, the piece A to be of the length and B of the breadth of the bottom of the case. These when fitted together by means of the two cuts in the centre will form a stand (see Fig. 47), on which will rest the plates. Put one of these stands in each glass case, and place the plates in the order shown in Fig. 42.

For the tops, cut two pieces of wood from a cigar-box to the shape of the case, and bore two holes in the correct positions for the terminals, and also a small hole in the centre for the vent plugs, in each piece. Fit these down flush with the bridges, and place a vaseline cup of any kind over each terminal. Fill with vaseline, and screw down the washers, which will keep them firmly in position. Next fill each case up with water through the vent hole, and run over with melted paraffin wax.

The accumulator is now complete, as shown by Figs. 48 to 50, and if it is desired to use it as a 2-volt battery, connect the two positive terminals together, and the two negatives in the same way. For a 4-volt battery, simply connect the positive terminal of one cell to the negative of the other by a piece of stout copper wire. Should the accumulator be used as a portable one, or in any case to prevent breakage, construct a box and line all four sides and bottom of the same with strips cut from an old blanket or any soft material, also putting one piece between the two glass cases. To denote the positive pole, paint that terminal with red paint, and the negative with black.

The cost will be about half that of a factory-made cell.

THE CARE AND REPAIR OF ACCUMULATORS

An accumulator, although so much to be relied on for constant current, high amperage, and other good qualities, needs careful attention to keep away certain annoying troubles. It is generally observed that when anyone (particularly an amateur electrician) purchases an accumulator, the sight of the smooth case, the evenly pasted plates, and afterwards the fine performance of the cell in general, cause him to rely on the accumulator doing its work constantly without any attention whatever, beyond seeing that the level of the acid is kept right. Consequently, whilst he is unaware, sulphate is forming on the plates, or else corrosion is making its presence felt on the terminals, and he wonders how it is that he cannot retain the full amount of energy in the accumulator. Periodical attention as here given is all that is required to keep an accumulator in good working order, and should any of these troubles creep on the cell, the following will enable the amateur to get rid of the most common of them.

Periodic Testing.—Make a point of testing the acid periodically if a hydrometer is at hand, or if the cell is charged at a garage or electrician's store, see that the specific gravity is tested here. The correct specific gravity for the acid in an accumulator is 1·20, and if the instrument reads a lesser density, add more pure acid; if a higher, add distilled water. Accumulators should not be left on charge too long. As soon as bubbles rise freely they should be taken off; nor should they be charged without the correct amount of current passing through them. The charging rate of 1 ampere for every 10-ampere-hour capacity of the cell may safely be adopted for charging purposes. Thus, if a 4-volt 10-ampere cell is to be charged, current not exceeding 1 ampere should be allowed to pass through it, and if a 4-volt 40-ampere cell, 4 amperes is sufficient. The correct table for any size of accumulator may be readily gathered from this example.

Discharge Rate.—The rate of discharge is also an important factor in the long life of an accumulator. To keep within a safe limit, a cell should not be discharged at a higher rate than one-tenth of its ampere-hour capacity; but it must not be taken that this rate applies to an ignition cell also. An ignition accumulator, on account of its alternating dis-

charge, will last twice as long on ignition work as on continual discharge. Therefore a 40-ampere ignition cell must only be discharged on continuous work at the rate of one-tenth of its ampere-hour capacity, which amounts to 2 amperes, and not one-tenth of its ignition capacity, which would be 4 amperes.

Short Circuits.—Shortage across the terminals of an accumulator must be watched for, and also throughout the circuit, especially if the cell is used for lighting a hut or small room, the walls of which may be damp. Terminals should always be freely smeared with vaseline to prevent corrosion by the acid spray or gases arising from the acid, and an accumulator subject to this trouble should have vaseline cups fixed to the terminals, if such are not already provided. There are various designs of vaseline cups in use, two of which are shown fixed to the terminals in Figs. 51 and 52. The more suitable one for fixing to accumulators not already provided with them is that shown in Fig. 52.

Laying Accumulator Up.—At the beginning of the summer months many people lay up their accumulators until the approach of winter. In these cases they should be given a good, steady charge, and the acid emptied out, then filled with water, after which they will take no harm

Sulphating.—This is one of the most common troubles to which accumulators are subject. It is noticeable in the form of a white powder or scale on the plates, and if allowed to accumulate soon fills up the intervening space between the plates, and eventually runs the accumulator down. Sulphate may form on the plates as the result of leaving the accumulator standing idle for any length of time without charging up, or it may be that tap water has been used for "topping up." Tap water is really unsuitable for the electrolyte, as it may contain iron and other minerals, and to obtain the best results it is most important that distilled water only should be used. This should be kept in a bottle well corked for use when required.

If sulphate has formed in an accumulator, first of all give the cell a good long charge at half the normal rate, as this may cause it to fall if caught in its early stage. Should this not, however, rid the plates of sulphate, take them out of the case and scrape them gently with a stick until all traces of the white adhering substance have been removed. Afterwards wash them in a bath of dilute acid, and replace them in the case. Fill up with acid of the correct density immediately, and give a good, steady charge. Should the plates have sulphated to a very great extent, they may require re-pasting. The most effective means of preventing sulphating is to give the cell a regular charge, whether in use or not.

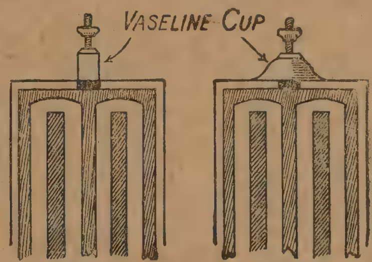


Fig. 51 Fig. 52

Figs. 51 and 52.—Vaseline Cups on Negative Plates

Buckled Plates.—Buckled plates are generally the evidence of over-charging. To treat a cell suffering from this trouble, take out the plates, and cut a sufficient number of boards, each having a thickness equal to the normal distance between the plates. The boards should be placed between the plates, and pressure applied by means of books placed on top of each other. No hammering or violent blows must be attempted, as this may either loosen the paste or break up the plates altogether. After restoration to their normal shape, the plates may be put back into their cases.

Re-pasting.—Plates requiring re-pasting must first have all the old paste removed. This may be done with the pointed end of a file. The paste for the positive plates is made by mixing red-lead with sulphuric acid and water of

equal proportions into a stiff paste in an old saucer. The negatives are pasted with litharge and dilute acid of the same proportions as for the positives. In mixing the acid for this purpose, add the pure acid slowly to the water, and not the water to the acid. Before using the paste let all the moisture work to the top and add more red-lead or litharge until the paste assumes the consistency directed.

Re-pasting is a far more difficult task owing to the plates being fastened to the bridge, and thus not affording the same room for working. Hence some device is needed to hold the plates in position whilst they are being pasted. For the negative plates, two pieces of wood of the same thickness as the normal distance between the plates and about ½ in. wide, placed between as shown in Fig. 53, will suffice to keep them apart.

Do not attempt to paste all three plates on each bridge at once; for it is obvious that in attempting to paste the middle plate some of the paste on the outer ones may be dislodged. Therefore it will be found better to leave the middle plates until a day or so after. This does not apply to the positives, there only being two of these on each bridge, as shown in Fig. 54. Put the plate to be pasted on a piece of glass, and press in the paste with a wooden spatula or an old knife, and leave to dry for a day or two. The positive plates must next be "formed" in a saturated solution of chloride of lime (½ lb. to 1 qt. of hot water, used cold) for about twenty-four hours or till bubbles cease to rise.

Broken Lugs.—In case of a broken lug, the best job is to have it re-burned by a practical man; but where the break is not a very bad one, a fairly good job may be made by first scraping all round the break until clean, and then soldering on the lug, afterwards giving the whole two or three good coats of anti-sulphuric acid paint to prevent corrosion.

Leaking Case.—Should an accumulator run down through apparently no visible cause, such as sulphating or falling paste, etc., an examination of the case should be made to ascertain if the trouble arises from a leaky partition, which, by allowing the acid from one cell to enter the other, establishes an electrical connection. To remedy this defect, take out the plates, and if materials are not at hand to effect the repair at once, the negative plates should be placed in clean water; the positives may be left. The case should be washed and allowed to dry, and angle plates made from very thin celluloid (see Fig. 55) cemented on each side of the partition, also along the bottom. (Use the cement given on p. 228.) This method may also be adopted for a leakage in the outer case as shown in Fig. 56; here the shaded portion denotes the angle plate.


Fig. 53.—Wood Strips Between Negative Plates


Fig. 54.—Wood Strip Between Positive Plates


Fig. 55.—Celluloid Angle Strip

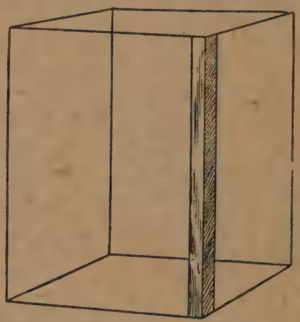


Fig. 56.—Celluloid Case Repaired with Angle Strip

Overhauling Engines

THE methods to be adopted in overhauling a steam engine vary with the size and the type. Parts that rub together at the highest surface speeds, and are at the same time subjected to the greatest pressures or strains, are, of course, likely to suffer first, and they may be enumerated as follow:

Main bearings, connecting-rod end bearings and eccentric straps, worn and requiring adjustment. Piston rings, worn or broken. Slide valves, worn or grooved. Cylinders: (1) bore worn untrue, (2) the glands worn, (3) the piston rod and spindles worn, (4) valve faces scored or worn untrue, and (5) steam joints leaking. Guide bars and crosshead worn untrue.

The extent of the repairs to be undertaken by the amateur will depend upon the tools available.

The main bearings are the first consideration. If these are worn badly, and are of the white-metalled type, then it may be found worth while to re-metal them. For this purpose the brasses must be removed, the old metal melted out, and then rigged up together in a position that will enable the bearings to be well heated. A core made of plaster-of-paris, bath brick, or a piece of round steel blackleaded, of a diameter less than the shaft, is set up in the centre of the bearing, and, after heating the bearing with a blow-lamp, the white-metal may be poured in. Clay, sand, or plaster-of-paris may be used to retain the metal at the ends, the bearing appearing as shown in Fig. 1 just before the metal is run in. When the metalling is completed the bearing brasses must be clamped together, bored, and then fitted, or bedded to the shaft. The latter is best done by smearing the journal with a film of red-lead and oil, and offering it to the bearing. The high places may then be observed, and the white-metal scraped down. The bearings should be relieved at the edges or horns, as shown in an exaggerated

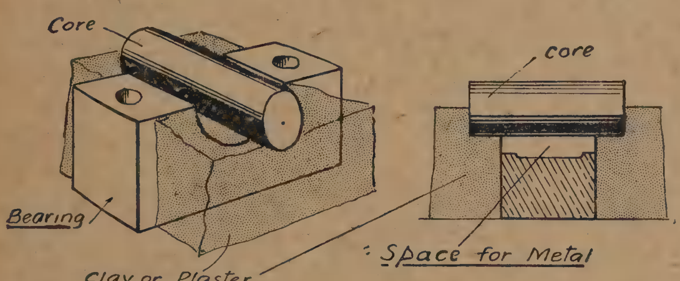


Fig. 1.—White-metalling or "Babbiting" a Bearing Brass

Fig. 2.—Clearance at Horns of Brass

degree in Fig. 2, for about $\frac{1}{16}$th of the circumference of the bearing at each joint. The tendency, when a brass gets warm in service, is for it to close in at the

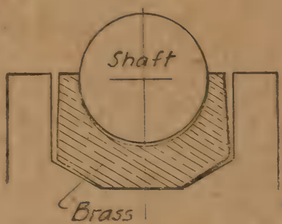


Fig. 3.—Heated Bearing Out of Shape

horns and to nip the pin. This tendency is cumulative as the closing in causes greater friction and more heat, and the brasses more firmly grip the pin or axle (see Fig. 3). Of course, the journal should be smooth before the above operations of fitting the bearings are proceeded with. If the journal or crank pin is scored it should either be turned up, or, if the marks are slight, fine emery-cloth (wrapped over a file) will remove the marks from the journal, the latter being revolved in the lathe at a fairly high speed. If the bearings have been previously filed away at the horns to get the maximum adjustment a new and thick liner may be required between them, as in Fig. 4. This liner should be of such a thickness that not more than $\frac{1}{100}$th of an inch play is allowed between the crown of the bearing and the journal, to allow space for the film of oil. All oil grooves should be cleared, enlarged, or re-cut as occasion may require, and oil holes, if necessary, re-drilled.

Where the bearings are simply adjusted and re-bedded (not re-metalled and bored) the alignment of the engine must be preserved should the bottom brass have worn the most. In the main bearings pieces of tinplate placed beneath the bottom brass may remedy this fault (see Fig. 4). In vertical engines the upper brass of the big end may show the greatest wear and require setting down. If this is not done and at the same time the main bearings are not set up, the piston will probably be found to touch the bottom cylinder cover. The exact method of preserving the original length of connecting-rod will depend on the design of the adjustable portions of the rod main bearings and crosshead.

In large engines, the adjustment for the clearances in bearings is tested by using soft lead wire. Four pieces may be used, two laid near the edge, and two nearer the centre, but clear of any oil grooves or holes. The bearing is then tightened up to the desired setting and slacked back until the lead wires can be removed.

The thicknesses of the squeezed-up wires are then carefully measured by a micrometer gauge. The clearances usually allowed in marine practice are :

$\frac{1}{1000}$ in. for every in. diameter of crank pin.

$\frac{1}{1000}$ in. for every in. diameter of main bearing.

$\frac{1.5}{1000}$ in. for every in. diameter of crosshead or little-end pin.

$\frac{1.2}{1000}$ in. for every in. diameter of eccentric sheaves.

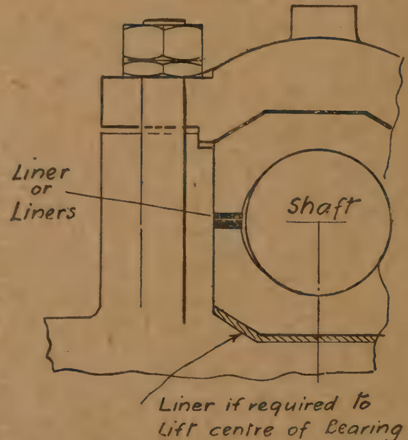


Fig. 4.—Fitting Liners Between and Underneath Brasses

The minimum is about $\frac{1}{100}$th of an inch. These measurements are taken at the crown of the bearing ; as already recommended, the bearing must be free at the horns.

In vertical engines, pistons seldom require re-alignment, but in horizontal

engines all parts have, owing to the weight, a tendency to wear down. Piston rings wear thin and allow the body of the piston to bear heavily on the lower

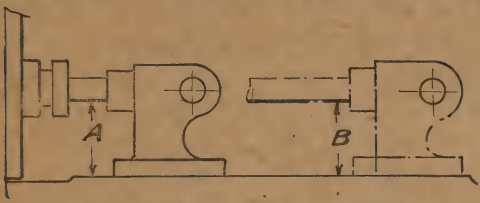


Fig. 5.—Testing Slides for Alignment

portion of the cylinder bore. A piston where there is no tail rod can often be set up by adjusting the thickness of the cod piece or pieces between the joint of the piston rings. The stuffing-box bush (if any) may also be renewed (or reversed), and the gland bushed and rebored. To allow for further settling down the piston may be set anything up to $\frac{1}{50}$th in. above its normal true centre line.

The guide bars should be tested for straightness. No doubt they will be found to have worn hollow, and in a horizontal engine the lower guide and surface of the slide block will be found to have worn most. The lines at the ends of the guides should be thinned down or increased in thickness (according to the design of the fixing) to set up the bars the amount required. The test for alignment is made in the positions A and B, Fig. 5.

To face up slide valves, a good surface plate is required, an assortment of scrapers, and some finely ground red-lead and oil, or prepared chalk; the surface plate must be bought, or an excellent substitute in the shape of a piece of thick plate-glass procured. The scrapers can be made from old files, and are numerous in form, being triangular, chisel-shaped, or hooked, as shown in Figs. 6 to 8. A useful tool can be made from an old 10-in. flat file, which, after having the teeth ground out, is forged down to about $\frac{3}{16}$ in. thick by $1\frac{1}{4}$ in. wide at one end, this end being turned over sharply at right angles (see Fig. 8, where A is the cutting edge). The hooked end must not be more than about $\frac{1}{4}$ in. long or it will not work well. The cutting edge requires grinding off at about 60°, hardening and tempering, an oilstone finish, and a very slightly rounded face to the cutting edge, the corners, however, being well rounded on so that they may not accidentally damage the work. Having got up the surface of the work as accurately as possible with planer, shaper, or file, smear a little of the thin red-lead mixture evenly on the surface plate, and press the work face downwards on the plate with a light rubbing motion. This will mark the high parts on the slide, etc., which must now be carefully taken down with the hooked scraper, which is used with a drawing action. Avoid taking too much off at once, or the whole of the work will need refacing afresh. After going over the high parts with the stroke in one direction, test again on the surface plate, and next time go over the work with the scraper strokes crossing the first set at a different angle.

The same processes will be found necessary to true up the port faces, and if well done the slide valve should adhere to the port faces when the cylinder is lifted, the surfaces being just smeared with a film of oil.

Piston rings should be renewed, and if they are purchased to ready-made stand-

Fig. 6

Fig. 7

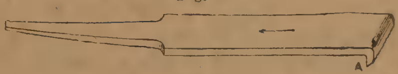


Fig. 8

Figs. 6 to 8.—Scrapers for Facing Slide Valves

ard sizes the high places should be noted, and the rings removed; these bright spots —denoting the surfaces touching—should be scraped down, until the rings bear all round.

Cylinders wear barrel-shaped, the centre, where the piston speed is highest, showing the greatest wear. In bad cases the

cylinder must be rebored and lapped. To test the bore use a rod gauge—a piece of rod with rounded ends, as shown in Fig. 9.

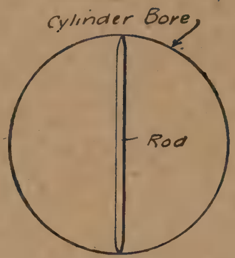


Fig. 9.—Rod Gauge for Testing Cylinder Bore

The overhauling of the engine should include refitting any worn bolts or studs, damaged nuts, and split pins. The steam joints should be all re-made, any of the good jointing materials now on the market being used. Thick soft card—a tram-ticket or a post card for small jobs—soaked in red-lead and oil makes a good jointing material where the temperatures are not high, and the joint is a small one. In fitting flanged joints, more especially oval ones, the face of the flange may be cleared off at the ends of the oval so that the force of the bolts makes the joint bear mostly at the centre. All oil ways should be cleared and enlarged where necessary, and new trimmings put in. Some graphite lubricant may be used for the first run and all bearings that exhibit any tendency to warm up should be slacked back—temporarily, at least. The engine should be put on a light load, and run at slow speed until everything appears to be satisfactory.

Fitting Up a Clothes Post

Of the many methods of fitting up line posts, the one shown on the opposite page may be recommended. The post stands quite firm in the ground, no matter what strain is put on it, and at the same time the operations of attaching, detaching, and stretching the line are done quickly and easily. Fig. 1 is the side elevation of one completed post, the dotted line showing the ground level. Firmness is secured by tenoning the post A into the sill B, and fixing the brace C across the angle. This latter effectually prevents the post giving way under any strain, while the end of the sill at D prevents the whole from lifting bodily. The post should be of yellow deal 4 in. square; the sill is the same width, but 1 in. less in thickness. The brace need be only 3 in. by 2 in., placed edgewise (see Fig. 3) and fixed with nails only.

Posts should enter the ground at least 30 in.; 3 ft. is still better. End posts in a drying ground need to be braced as shown, but not the intermediate ones. The straight posts are planted in the ground, and a hole bored through at the proper place for the line to pass through.

The line-tightening arrangement shown in side elevation in Fig. 1 is fixed to one only of the end posts. A pulley E is fixed near the top of the post, so that the line will pass over it, previous to fixing the end to the forked lever F. The last mentioned can then be engaged under one of the bars fixed in the plates G, and, on pressing it down, the line is stretched very tightly. The line is kept taut by passing an iron pin through the hole in the small plate H, which confines the handle of the lever close to the post. The degree of tightness can be regulated according to the bar the end of the lever is placed under; the lower the bar the tighter the line. Fig. 2 shows the whole arrangement in front elevation, while Fig. 4 shows one of the plates G, the open holes being for screwing to the post; the black dots represent the ends of the bars riveted through. In Fig. 5 the plates G are shown with the bars in elevation.

Fig. 6 is the side and front view of the forked lever, the bar J being for the attachment of the line; and Figs. 7 and 8 show one of the plates H and the pin which passes through them to hold the lever in its place. The lever should be attached to a small chain, so that it can they may be dispensed with, but the result will be neither so convenient nor substantial. Instead of making the forked lever of iron, it can be made of wood the same width as the post, to which it can be fixed with an ordinary butt hinge. This enables the plates G and the

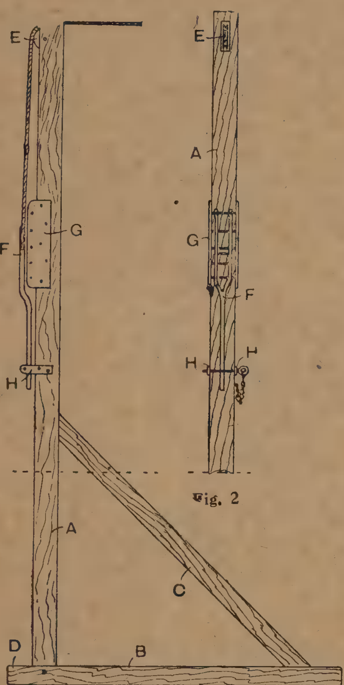


Fig. 1

Figs. 1 and 2.—Side and Front Elevations of Clothes Post

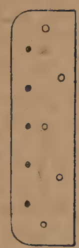
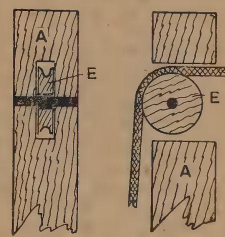


Fig. 4.—One of the Side Plates

Fig. 6.—Forked Lever



Figs. 9 and 10.—Sections through Post with Pulley in Position

Fig. 8.—Pin

Fig. 7.—Plate for Fixing Lever

Fig. 5.—Bars Riveted in Side Plates

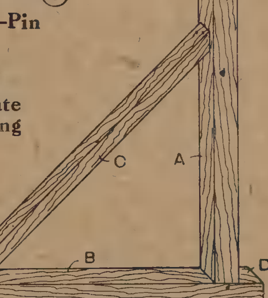


Fig. 3.—Brace at Foot of Post

be fixed to the post permanently, as in Fig. 2. Figs. 9 and 10 show sections through the top of the post and pulley. This latter may be an ordinary wood pulley running on an iron pin; or it may be a brass pulley. If an iron pulley is used, the line will gather rust from it, and iron-mould on the clothes will result.

Should the preparation of the iron plates, lever, etc., be too difficult or expensive, bars in them to be dispensed with, but the advantage of the regulating bars is lost. The plates H may be of wood, and a piece of wire will do for the pins, thus obviating the greater part of the expense.

The posts and the braces will last much longer if the parts immediately under and above the ground are cased in oak, this being much better than the use of tar or any other so-called preservative.

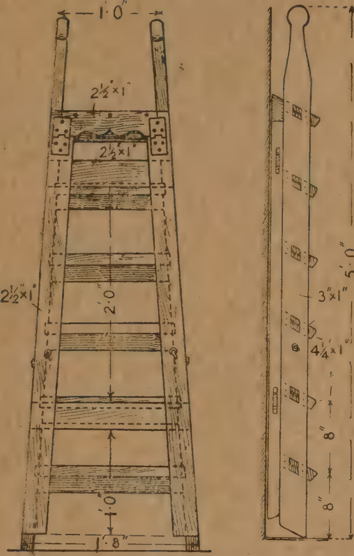
Making and Repairing Step-ladders

A STEP-LADDER is one of the first things required in getting a home in order, and, of course, must be in continual use to keep it so. It is expected to stand a good deal of rough usage and neglect, yet, as a rule, people are not prepared to pay the price of a really strong article, and consequently the manufactured steps obtainable from hardware stores are often things that soon get shaky and unsafe. There are comparatively few people who consider the appearance of the step-ladder; yet it is often needed in the drawing-room, and there is good reason for making it presentable. A step-ladder should be firm and safe to stand upon, convenient to handle, and not unnecessarily ugly. The making of such an article will now be described, it being a piece of work which can be done at home by the amateur joiner.

Fig. 1 is a photograph of a step-ladder that has been in use for fifteen years, and has been found entirely satisfactory in every way. The making of it is not such a very simple matter as might be thought, but the instructions here given will make the job quite straightforward. The size is that which is most frequently required, but may be altered where necessary. The material costs but little, being straight-grained deal; and full dimensions are given in Figs. 2 and 3. The wood need not be fully 1 in. in thickness; what is called "1 in." is really $\frac{7}{8}$ in. finished, but all the other measurements should be kept full.

Fig. 1.—Strong Step-ladder

First, the two side pieces should be cut 5 ft. long by 3 in. wide, and shaped at the top ends as shown; for comfort in handling, a bead may be run on the edges, or they may be slightly rounded. They should then be set out for the steps as shown by Fig. 4. In this case every joint is mortised and tenoned,



Figs. 2 and 3.—Two Elevations of Step-ladder

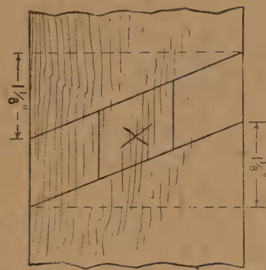


Fig. 4.—Part of Side Set Out for Step

Fig. 5.—Housing or Trenching for Step

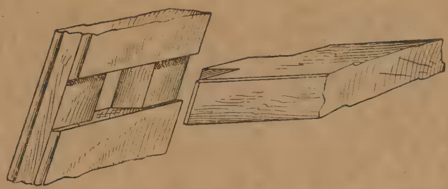


Fig. 7.—Step Mortised and Tenoned to Side

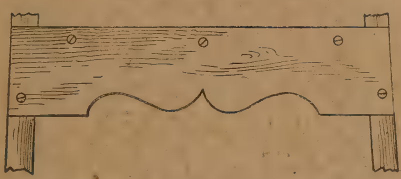


Fig. 10.—Shaped Bracket Piece

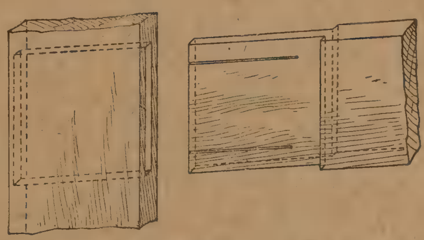


Fig. 11.—Mortise-and-tenon Joint in Back Frame

Fig. 8.—Shaped End of Step

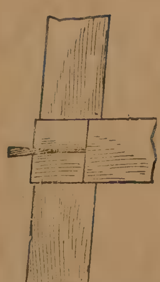


Fig. 9.—Wedged Joint

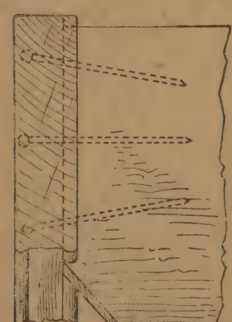


Fig. 6.—Nailing of Step to Side

but some joiners would do so only with the bottom and top steps, those between being nailed; thus the work may be modified according to the worker's ability or convenience. In any case, the setting out is the

Fig. 12.—Detachable Shelf Fitted to Step-ladder

same for housing or trenching in the ends of the steps about $\frac{3}{16}$ in. deep (see Fig. 5). The top and bottom steps must be fitted first so that the exact length of the others may be ascertained. If the joints are to be nailed they should be well fitted; $2\frac{1}{2}$-in. oval nails should be used, first boring holes to prevent splitting. Glue must be applied and the centre nail driven straight, the two others being "skewed," as shown in Fig. 6.

The mortise-and-tenon jointing (see Fig. 7) is much better workmanship. Fig. 8 shows the exact shape of the step ends: a saw kerf is made in the tenons, and wedges prepared. The glue should be hot and strong, but not too thick, and it must be applied quickly, first gluing the mortise holes and trenches of one side and the corresponding step ends, and then getting them together quickly. If necessary, nails may be driven at each side of the mortises to draw them up close. Then the other joints are got together in the same way, finally driving in the wedges, as in Fig. 9, to tighten the tenons in the holes. Take great care that the step-ladder is correct in shape before being put aside to set. When the glue is hard the joints will require levelling, as will also the surplus back edges of the steps.

The bracket piece for hinging on the back frame may next be made and screwed on as shown by Fig. 10. The curved shape is not essential, but improves the appearance.

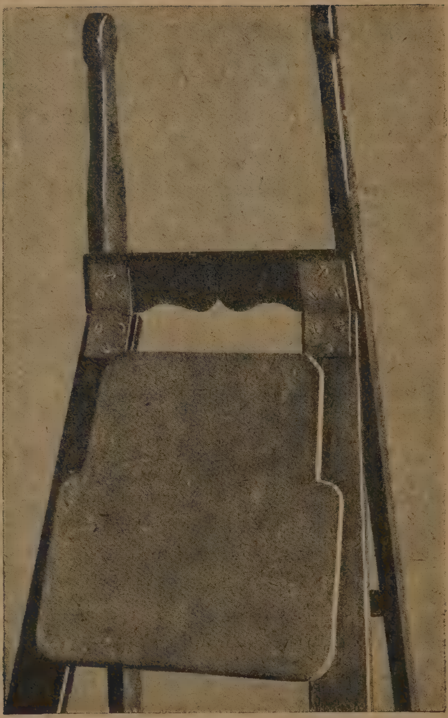
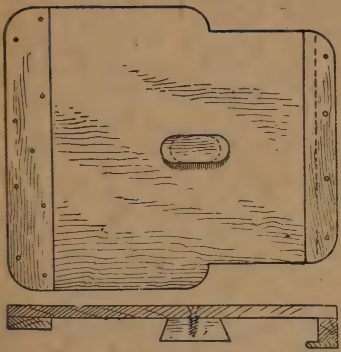


Fig. 13.—Step-ladder Shelf Out of Use

Now the back frame can be made. It consists of two lengths of wood 3 ft. 10 in. long by $2\frac{1}{2}$ in. wide, and one length 1 ft. 7 in., and another 1 ft. 3 in., both $2\frac{1}{2}$ in. wide. The two longer pieces may be laid in their position on the back of

the steps, and the other two laid across exactly in the position shown in Fig. 2; then they can be marked for the mortise-and-tenon joints, which joints are made as shown by Fig. 11, saw kerfs being cut in the tenons for the reception of wedges. be necessary to countersink the screw-holes at the other side. The reason for this is that the finished step-ladder is made to stand flat up against the wall when not in use, as in Fig. 3, and in time the round of the hinge joint would



Figs. 14 and 15.—Plan and Elevation of Detachable Shelf for Step-ladder

Fig. 18.—Strengthening Repaired Step-ladder with Corner Struts

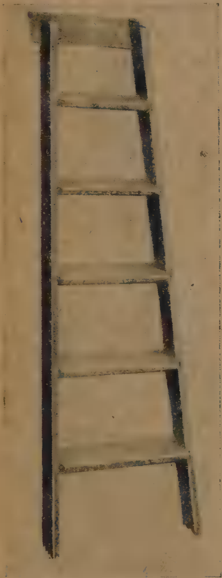


Fig. 16.—Step-ladder to be Repaired

Fig. 17.—Method of Dowelling New Pieces at Feet of Old Step-ladder

When the frame is set and levelled off at the joints, the top ends should be cut to fit nearly against the bracket piece, and hinged with strap hinges. These should be put on with the round of the hinge joint let into the wood, and it may wear a deep mark in the wall. The ropes, which are of window sash line, should be about 2 ft. 3 in. long to give a splay at the foot of about 3 ft. 6 in.; they are passed through holes bored just below the third step, and knotted on the outside

of the framing. The foot ends must be cut to fit the floor, to stand level, and to get the steps level.

Any nail holes or defects should be filled up with putty and three coats of paint should be given, allowing a day between each to dry and several days afterwards to harden. The paint should be well stippled into the end grain at the foot ends. The painting is necessary to preserve the wood as well as to improve the appearance and to provide a washable surface. It is a mistake to leave unpainted steps exposed to rain, wind, and sun, as is often done.

Fig. 19.—Testing Step-ladder for Levelness

A Detachable Shelf.—This is a great convenience on a step-ladder, either for a workman using tools, or for the wash-bowl and chamois leather for cleaning windows, etc. The one shown in Fig. 12 is simple to make, and when not in use may be hung on the back rail as in Fig. 13, or a hole could be bored in it to hang on the wall. It is made from a piece of board 1 ft. 2 in. long by 1 ft. wide by $\frac{1}{2}$ in. thick, cut to the shape shown in Fig. 14. A batten is glued and nailed across even with the back edge to give strength, and a piece $\frac{5}{8}$ in. wide and the thickness of the step is glued and screwed on the front edge; then a piece 1 in. wide by $\frac{1}{4}$ in. thick is glued and screwed on as shown. It will then hook on to the front edge of the step, and a wood turn button, with the ends bevelled in, is screwed on to turn against the back edge (see Fig. 15). A similar arrangement could be fitted to any existing step-ladder.

REPAIRING A STEP-LADDER

There are probably as many rickety steps in general use as there are safe ones, and it is advisable that they should be repaired without delay. An example is shown by Fig. 16, which is a photograph of what is left of a cheap step-ladder after about three years of use and neglect. This kind of step-ladder, being nailed in every joint and manufactured for cheapness, is not very strong to begin with; but had it been strengthened with a few extra nails or screws and painted it would not have reached its present condition for many years. The back frame and top step have been completely broken up and thrown aside. It is very loose in all the step joints, somewhat split and rotten at the foot ends (owing to absorbing wet from the ground), and was thought to be not worth repairing. Considering, however, that a new one of the same make would get into pretty much the same condition, it is decided to repair and improve this one.

First the joints are extra "skew" nailed, and a new top step with rounded edges and corners is made and securely nailed on. The bad foot ends are cut off square and new pieces jointed on with $\frac{3}{8}$-in. dowels in the manner shown by Fig. 17, this illustrating the steps gripped in the bench vice for convenience in working. When these are well glued and knocked up close, two pieces of $\frac{1}{2}$-in. wood are prepared to fit from the lower side of the first step to the foot end, and are

well glued and nailed across the joints on the inner side.

To give extra strength and rigidity, two corner struts (cut from a piece of blind roller) are well fitted, glued and nailed as shown by Fig. 18. A back frame is made with mortise-and-tenon joints, as previously described; but in this case it is not necessary to reverse the hinges, as the rounded edges of the top step overhang. Next the steps are levelled. To test the steps for levelness, a bar of wood is rested on a step (Fig. 19), and the back frame pulled out till the bar becomes horizontal; then the feet are cut and the stay ropes tied. All the nail heads are punched a little below the surface and the holes filled with putty; and any rough splintery corners first planed and then levelled with coarse glasspaper; finally, the ladder should be painted, and will then be much better than when new.

Two Easy Repairs

Repairing Gas-meter Brackets.—The wooden brackets used to support gas meters are often of flimsy construction, and are liable to get broken, especially if the meter is in the coal-cellar. A prompt repair is urgent, otherwise there

Fig. 1.—Repairing Gas-meter Bracket

may be an injurious strain on the meter or pipes, giving rise to a leakage. The part commonly broken is the centre portion of the bracket that upholds the shelf, which gets snapped off, as seen at A in Fig. 1, above. In such a case, a good strong repair may be effected in five minutes by nailing two pieces of firewood across from the edge of the shelf to the back of the bracket, to act as struts, as at B and C in the illustration.

Missing Finials of Cornice Poles.—To replace damaged or missing finials on wooden cornice-poles, drawer knobs of suitable shape and diameter may be used. They should preferably be of the kind furnished with a wooden or metal

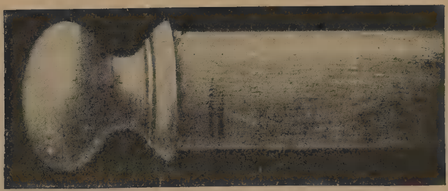


Fig. 2.—Using Drawer Knob as Finial

screw. If a metal screw, it is only necessary to start a hole with a gimlet at the end of the cornice-pole and to screw the knob home; while with a wooden screw, a hole just large enough for it must be bored, the screw being then well coated with glue and pushed in. Plain knobs of the shape here illustrated are effective, though in some cases flatter ones look better; knobs carved or otherwise ornamented may, however, be employed if preferred. For enamelled cornice-poles, the knobs may be given two coats of enamel to match.

Making Mailcart and Perambulator Hoods

HOODS for mailcarts, etc., can be divided into three distinct classes. In the first, the frames are of wood, and in the second they are of iron. The third is a tacked-on hood, which possesses the advantage of being draught-proof, and can be adapted to fit almost any shape of carriage back and sides. But it has the disadvantage of not being detachable. Wood frames are those which are made with front and back bows of wood. Iron frames are those which are built up of metal. Wood or iron bows can be used for the tack-on hood. Fig. 1 shows a hood suitable for a mailcart, and Fig. 2 a reversible hood for a perambulator, which has the advantage that it can be used at either end of the carriage. Wood and iron frames will first be treated.

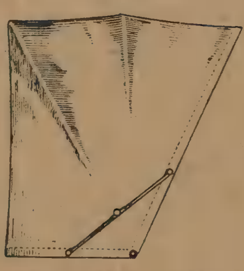


Fig. 1.—Mailcart Hood

Fig. 2.—Perambulator Hood

Taking Measurements.—The measurements for a hood frame should be taken about 2 in. from the end of the woodwork of the cart, as shown in Fig. 3, the projecting ends leaving room for canopy fittings to be fitted. Take a piece of cord, or preferably a tape measure, and, after marking where the hood is to be fitted, measure round the outside of the cart. In an ordinary cart this measurement will be about 39 in. or 40 in. Then measure across from outside to outside, which will be about 15 in. or 16 in. It is not a good plan to fit hoods right on the top of carts and perambulators, as it is difficult to prevent draught. Therefore the measurements should be taken about $1\frac{1}{2}$ in. from the top of the body. Next lay a piece of wood across the top of the carriage where the hood is to be fitted. Then take a piece of wood about 2 ft. 5 in. long and stand upright on the upholstered seat. The height of the hood can then be obtained by drawing a line on the upright piece underneath the piece laid across. This will be between 18 in. to 20 in.

Making an Iron Frame for a Mail-cart.—In building an iron frame, take a length of $\frac{3}{4}$-in. or $\frac{5}{8}$-in. flat iron $\frac{1}{16}$ in. thick, mark off the length round the body, and add $2\frac{1}{2}$ in. extra for the ends to be turned. After cutting off the rod, mark up $1\frac{1}{4}$ in. each end, to form the thimble holes, and file away as shown in Fig. 4. Now heat the ends, and bend them to the shape shown in Fig. 5. The hole should be $\frac{3}{8}$ in., and must be cleaned out to that size. Fit the bar round the body of the cart, but it should not be too tight. The corners will be nearly or quite square.

Next proceed with the front bow, the height of which was taken with the upright piece of wood. Twice the height and the width across and $2\frac{1}{2}$ in. for the ends will be the length required. Bend the ends as was done for the back bow. Then set out, on a piece of 1-in. board the width of the cart, a template as shown in Fig. 6. Mark the corners with the compasses opened to $2\frac{1}{2}$ in., and cut away waste wood. Then bend the front iron round this, to form the corners.

The inner bows are made from $\frac{1}{4}$-in. or $\frac{5}{16}$-in. round iron. The first bow is the same size as the front; the second is 1 in. higher. Bend round the ends, and flatten to about $\frac{1}{8}$ in., leaving a clear hole, as in the front and back irons.

Two brass hood thimbles are now required. Pass one through the front iron, then through the first bow, then through the second, and finally through the back iron, open out the end of the thimble, and the ironwork is held together. Do the same on the other side. Next drill a $\frac{1}{4}$-in. hole in the centre of the back iron, also drill a $\frac{5}{16}$-in. hole $8\frac{1}{2}$ in. from the thimble on each side of front bow, and rivet in two hood-joint pins. Place a hood joint on one pin and stand the frame upright. Then spread the frame open (the two bows can lie flat), and when the front iron is about 7 in. out of the upright, mark with the loose end of the joint where the back iron pins are to go. Drill holes, rivet in the pins, and the frame is complete.

Making a Wood Frame for a Mail-cart.—For a wood frame make the two bows as for an iron frame. Take a length of $\frac{3}{4}$-in. by $\frac{5}{8}$-in. ash, the size of the front iron, less the $2\frac{1}{2}$ in. for bending the small thimble hole, and mark where the corners will come. Bind a piece of flannel round the mark, and lay on the top of a vessel containing boiling water, letting the flannel come as much as possible in contact with the water. The water will be taken up by the flannel, and the wood will soon be in a condition for bending round the template (Fig. 6). Tie with string and leave to dry.

The back piece can be bent or made in three pieces, fixing the corners with two angle plates inside. Make four plates similar to the ends of the front iron in the iron frame about 6 in. long. Drill for screws, and screw on the outside of the bows. Then use the thimbles as in the iron frames. The hood joints for wood frames are screwed on, the $\frac{1}{4}$-in. hole through centre of back being necessary as before.

Frame for Tack-on Hood.—Tack-on hoods require the same bows, etc., but no back iron. Simply the front bow and two inner bows.

Perambulator Hood.—The frames for the hood of a perambulator can be made of wood or iron. The size must be taken from the centre of the body, and this measurement determines the height which allows it to become reversible. The bows are the same height as the front, and they should not differ in height as in a mail-cart hood.

The Lining and the Covering.—Materials for hoods include real, but common, leathers, fabrics of various kinds, rexine and similar artificial leathers, American cloth, etc.

The setting out of the leather cloth and lining may be done as follows: Fix on the hood joints, tie a piece of string round the centre of the front iron, twist the end round the first bow, then round the second, and finally round the back iron. Now adjust the frame in an open position. For a perambulator adjust all at equal distances; for a mailcart get the back bow square with the back iron, and equalise the distance between

the first bow and the front iron. Then make a chalk mark on the top of the frame where the bending begins. Do this on both sides. Take a sheet of stiff paper, and pass down behind the hood joints, cutting the paper at A A where hood pins come. Then fold the paper round the iron at the bottom and front. Do not go beyond the corner of the back iron. Fold paper to the depth of $1\frac{1}{2}$ in. inside, and fasten it to the frame with pins. Trim off the paper on the top level with the chalk mark on the top of the frame, and cut up the paper at the back. This should give a pattern as in Fig. 7. Then hollow out the pattern, as shown by the dotted lines, to a depth of $\frac{1}{4}$ in. in the centre. Measuring across the top of the frame on the chalk marks will give the width of the back. The length can be obtained by measuring round the frame, allowing 3 in. on the length. Cut out two of the side patterns in leather and one piece for the back, which for this design of hood is a straight piece. Fig. 8 shows the method of cutting from one piece of material.

Linings are of several kinds of material —cashmere, twill, cloth, serge, sateen, flannelette, etc. Whichever is used, cut as for the leather, but allow 1 in. on the width of the back.

The hood leather can be stitched plain or piped; piped hoods look best. To make the piping, take a strip of leather about 1 in. wide, fold over on a piece of fine cord, and machine up. When stitching up the leather fold the piping in and sew all together. The piping will show on the outside when finished.

Attaching a Hood.—In tacking on the hood begin about half-way down the bows, and bind a strip of lining round until the opposite side is reached. Fasten the loose end by tacking. These strips should not be wound thick. Take the lining and suspend inside the frame. The seams of the lining must be stitched to the material wound round the bows, seeing that the lining is central. Then sew across the top of the bows, making a stitch about every 2 in. and taking up the lining. Do not pull the stitches very tight, just bring the lining up to the ironwork. Next pull the leather over the framework and adjust centrally. Fix in position by turning over the front and back irons, and passing a stout pin through the seams outside, two at the front and two at the back.

The following is another method of fixing the hood, which should be extended, with both joints fixed on. Pull the bows up into the corners of the leather, and pass the leather down behind the hood joints (the leather must not be cut as for paper pattern). Then pull the leather at the joints opposite the thimbles and pass a pin through each side of the thimble hole, turning in the leather. Work from the seam at the bottom of the back, pulling the leather and fastening

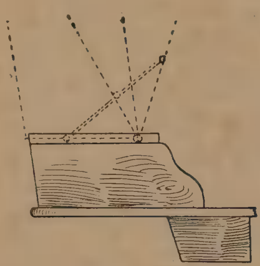


Fig. 3.—Position of Frame on Mailcart

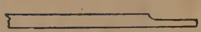


Fig. 4.—End of Rod Filed

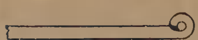


Fig. 5.—End of Rod Bent

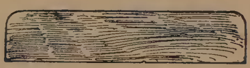


Fig. 6.—Template for Bending Front Bows

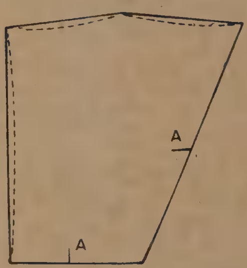


Fig. 7.—Pattern for Mailcart Hood

about every 3 in. until the top is reached. Then do the other side. Pull out all creases and wrinkles; the leather will stand plenty of pulling. Should a wrinkle be obstinate, loose back the joint, pull the leather tight, and, while holding round the iron, tighten up the joint. This will prove effectual if properly done.

When a good fit is obtained at the sides, mark by piercing where the hood-joint pins will come through, slacken out the joint and pull over on the pin. Be careful to place a pin through the leather at this spot, to prevent tearing. Then replace the joint and expand. When this has been accomplished, split the leather up at the bottoms until it clears the thimbles, and fold in the ends as in Fig. 9. Now pull the back leather tight and fasten. Turn over the hood and pull out the lining, pulling moderately tight, and fasten. The pins used should not come through the leather; the lining should be folded neatly up, to the inside of the front of the back iron all round. Next stitch on all together, only just showing the stitches on the outside, making a stitch about every inch. Pull tight in sewing, and remove the fastenings as proceeding.

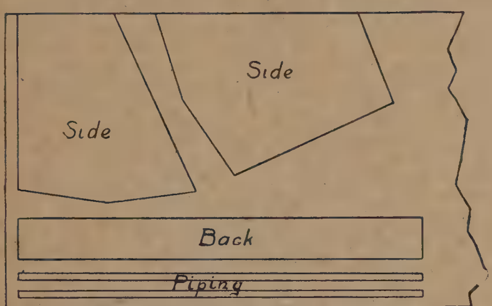


Fig. 8.—Cutting Material for Mailcart Hood

No stitching is required in a wood frame beyond the lining, the whole being fixed with tacks. Go through the same process in stretching, etc., only fastening with tacks. Trim off the leather and lining after fixing, and cover with gimp. Plates for screwing on the hood by means of brass thumbscrews can now be secured to the cart, fixing an ordinary screw through the $\frac{1}{4}$-in. hole drilled in the back of the cart.

For a tacked-on hood fix the three irons to the cart first, adjust the bows at the proper angle, and cut out the pattern. Stitch up and fix to the bows, as for iron and wood frames, except that the leather is only fixed to the front iron, and that only temporarily. One end of the hood joint is screwed to the cart by a round-head screw.

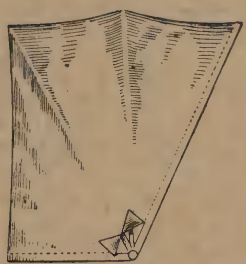


Fig. 9.—Method of Turning-in Leather of Hood

Now tack both the leather and lining round the cart. Then trim off any surplus material and cover with gimp. Then stitch or tack round the front. If it is not free from creases, etc., advance the hood joints a little.

Re-covering Hoods.—To re-cover the hood of a mailcart or perambulator remove the old leather and untack in sections. Use one side and back as a pattern, and cut out. If for a wood frame, allow $1\frac{1}{2}$ in. extra for pulling over, which will be trimmed off. Stitch up and fix as described above.

All the necessary metal fittings for making these hoods can be obtained from an ironmonger.

Stoves and Ranges: Fixing, Remedying and Improving

Fixing a Close-fire Range or Kitchener.—In Fig. 1 is given a front view of a close-fire range or kitchener, with a left-hand oven A, side boiler B, fire C, drawing-out fret D, ash-pan E, soot-doors F, of which there are three in the back covings, one below the oven, and one in the hob, directly over the side flue of the oven, and which is not shown; dampers G, and vent damper and bearer H. Fig. 2 shows the formation of the flues, connected with the range. Starting from the fire, the oven flue goes across the top of the oven, under the hob, down the side next the jamb, thence under the oven, and round to the far side of the feather J, and afterwards up the back to the damper G. This should in every case be tight-fitting, with no space for air passing when closed, otherwise the control of the oven is not as it should be.

The boiler is usually side heated, with a perforated, protecting plate L, but some are fitted with a collar, to give a hot-plate flue. This collar is just the width of the opening which is in the hob for filling water, extends about 2 in. down, and usually has an aperture left in it, to take off steam from the boiler. The hot-plate flue goes across the top of the boiler, all round the collar, and up the back of the coving as shown. The direct flue to the chimney goes straight back from the top of the fire, close below the hob joining plate, if the latter is thick enough to stand the heat, but if not, thin brick should be laid along the top of the flue as a protection, then up behind.

Fig. 3 is a plan of the ash-box, and the flue under the oven, with the feather, or oven rest, indicated. The brick rest under the oven next to the ash-pit, and the upright flue behind the oven, are also shown.

Fig. 4 is a plan of the range, with the hobs removed, showing the oven, with the side brick in position next to the fire, and the hob packing N across the front and back of the top of the oven, to prevent the drawing of cold air. The fire-grate is shown in position, and the sloped brick back of the fire and the direct flue are indicated. The collar is shown, with the hob packing round the top of the boiler, forming the hot-plate flue.

When fixing, it is best to set in the oven front and hob, the boiler front, and fire joining. Holes are cut in the jamb for the projected parts of the hobs, which keep the range from "travelling" out. When this is done, and all set straight, the level of the hobs from front to back should be seen to, and the feather below the oven either packed up or cut down into the hearthstone, as required.

If side covings are required by the customer, and supplied with the range, the best plan is to level the hobs to suit the side coving and jamb-moulding, making the latter lie hard on the stone jamb. See that the boiler hob and joining hob at the back of the fire get into their places, as if not properly measured the range may

have to be cut into the jambs on either side, or both sides, of the fireplace. This done, mark the position of the oven front on the hearthstone, and remove everything except the oven and oven front. Lay with bricks below the oven to the level of the soot cleaning door F (Fig. 1), and fix the side of the ash-box, as shown

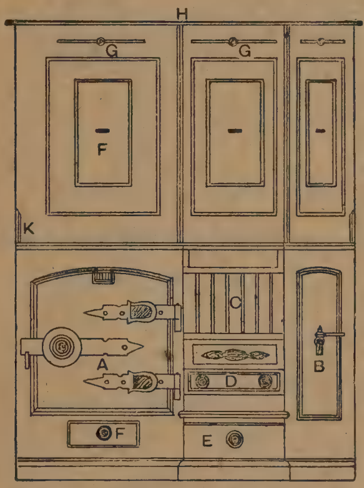


Fig. 1.—Elevation of Close-fire Range

Fig. 2.—Flue Formation for Close-fire Range

Fig. 3

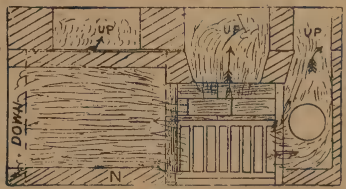


Fig. 4

Figs. 3 and 4.—Horizontal Sections at Ash-box and Hob Levels

in Fig. 3, hard against the bottom of the oven.

Next, against the side of the oven feather, and behind the oven, start the brickwork, as in Fig. 3, to form the oven flue. Gradually slope if required, so that the flue is directly below, and the area the same as, the dampers at the hob level. Watch that the position of the oven has not altered, and build up to the level of the damper frame, first seeing to the correct distance back required for the back covings, and leaving room for a mortar bed. Refix the boiler and fire fronts, and set in the ash-pan.

Build the bricks round the pan, and against the boiler front, to form a rest for the boiler, the level being got from the hole left for the draw-off cock. Remove the ash-pan, and build up to the level of the bottom grate. If required, project the brickwork below the grate and above the pan, so that the grate is against the brickwork, and at the same time carry up the oven flue. Leave holes if required for the draw-out fret in the brickwork.

Now put the boiler on its bed, and after

seeing that it is in its right place, pack in next the jamb and behind the boiler. The hot-plate flue over the top of the boiler can next be fitted, and also the hob packing over the oven. After this the back of the fire and the direct flue can be formed; the hobs being bedded down, when the round corners of the fronts have been built up airtight. The back of the fire should be sloped off, to suit the brick supplied to place against the oven, and the latter should be bedded against the oven plate.

The work is now at hob level, and the flues should now be all directly below the dampers, and of the same size as they are. Build up and fix the oven flue, fixing the damper securely, making it airtight, with a mortar joint between the covings and the bricks. Follow similarly with the hot-plate flue, and this leaves a bed for the middle plate in the covings. This should always overlap the others, and should be screwed up, with the damper screwed on. Set a brick alongside each of the dampers, and slope off so that soot cannot rest.

The skirting shown at K (Fig. 1), or the side covings, as the case may be, are now put on, mortar being bedded along on top of the hob to make it airtight. The vent damper follows, and should be fixed tightly to the lintel, the bar being rested on the jambs; and in order to save sagging in the centre, the latter should be bent upwards before being set in. This finishes the building in, and the odd loose parts can now be put in, and the flues cleaned, ready for firing.

The writer has tried several kinds of mortar for this work, and finds that the best is a mixture of common clay, soft sand, and a little hair, ground in a pan mill. This surpasses both fireclay and mortar in this class of range.

Fixing an Interior Grate.—The front of an interior grate is usually from 16 in. to 22 in. wide, and the height varies according to the size of the fireplace. Fig. 5 shows the grate A in position, with the tiles B set on both sides and across the top. These latter are set behind the edges of the grate, and also behind the wood check C, which is secured to the jamb, and has a bevelled joint at the two inside angles D. The fire-grate front E is removable, as is also the ash-box front F. A brick back G, sometimes in one piece and often in sections, sits on the bottom grate, and the canopy H overhangs the fire.

Fig. 6 is a sectional elevation, with the tiles, the grate front, and the brick back removed on the one side marked J, to show the brickwork in elevation. On the other side K is shown the brick back (secured to the front by wrought-iron bands), along with the two $1\frac{1}{2}$-in. by $\frac{1}{2}$-in. tie-bars L, which are fixed to the band at the top, and the back of the iron ash-box at the bottom. The bottom grate M lies on the top of the ash-box, or stool, as it is sometimes called, and has a check N raised round to hold the brick back in position. The building behind is sloped at the back and side from O, the damper, as shown at P.

A 3-in. by $\frac{1}{2}$-in. flat bar iron is carried across, as indicated at R, to carry the bricks which form the ground for the tiles which cover the front. These bricks should be wedged hard up to the lintel.

Fig. 7 is a plan taken just above the bottom grate, showing the brick back resting thereon, the tie-bar built in, and the front, tiles, and fire-grate in position, with the tile hearth indicated in part; while Fig. 8 is a plan taken at the top without the damper, showing the back building sloped off, to keep soot from lodging. The hood is also shown projecting, and the forward projection of the brick back over the fire.

Great care should be taken in the fixing of the interior so as to show the same size and bevel of tilework on each side. To get this the grate must stand exactly plumb. The first thing to do is to lay the hearth with the tiles, and these should be thoroughly soaked in water beforehand. If the hearth is sunk—that is, finished flush with the floor—a good plan is to check a part out of each end of a straightedge of the thickness of a tile. In drawing off the mortar the sunk part of the straightedge resting on the floor allows of the correct sinking being left for the tiles.

If a hearthstone is already in position and a tile hearth has to be laid on, the hearthstone should be cut to form a key for the cement. Two short pieces of wood ½ in. thick, laid on the floor alongside of the stone, give a level bedding in drawing off the cement. When well set the hearth should be protected, and then the grate may be laid on.

Set the front to the correct position, and, if possible, so that a multiple of half tiles suits the panels. Secure temporarily in this position and build solidly behind and at the sides, leaving sufficient space to allow of a rough coating of cement plaster for bedding the tiles. The tie-bars should be well secured, and care should be taken that the grate is not pushed out of its place. Frequent testing of this is desirable, and usually pays in the end. The damper supplied with the grate should be carefully looked after and securely fixed in its place, after which the back and sides are sloped off as at P.

The front can now be built up, the bar R (Fig. 6) being put in and the brickwork built over it hard against the lintel. Next plaster the brickwork roughly with a good rich coating of cement mortar.

In starting the tiling the joining across the top of the fire should be looked to and also the finish at the top, and if required the cut tile should be laid at the bottom. The tiles should be laid perfectly level behind the check C at the jamb, or if there is no check, then against the jamb, and also behind the edge of the interior front. When all is tiled, pure cement should be rubbed into the joints to hide any unsightliness.

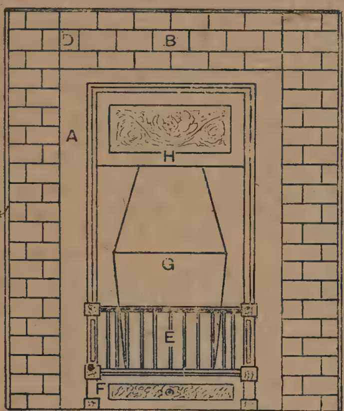


Fig. 5

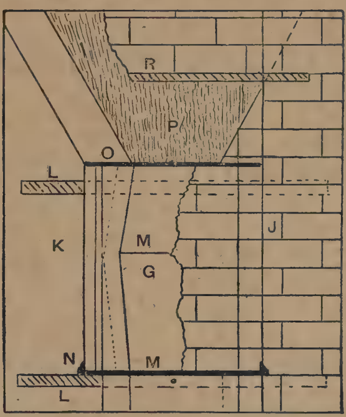


Fig. 6

Figs. 5 and 6.—Front Elevation and Vertical Section of Interior Grate

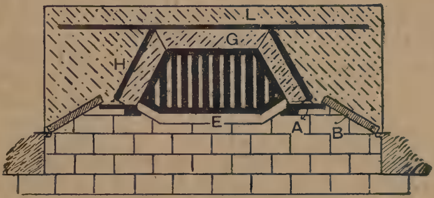


Fig. 7.—Plan of Interior Grate

Fig. 8.—Plan of Top of Grate, Without Damper

Sometimes the panels are supplied in one piece and built in with hooks to hold them in position, and in this case the interior front is laid in position along with the panels. The position and shape is then marked on the hearth, after which the grate is taken out and the panels built up behind as fixtures. The back of the

interior grate can also be built up to the level of the first tie L, or the hooks as in some cases, and the grate then set in.

One objection to this style is obvious; the builder cannot see his work, and consequently it is sometimes rough, and, working loose, fails to hold the ties, and the interior being so left, is pushed out of its place by the dry mortar falling down behind.

WHEN THE COOKING RANGE GIVES TROUBLE

It will be found that there are general working principles possessed by all cooking ranges alike, and in almost all cases it is the proper understanding, or else the neglect, of these that brings about successful working or failure.

Sluggish Draught.—The rather common complaint that a range lacks draught has led, in not a few instances, to a belief that the range—in make or structure—is accountable for the draught or air movement. It is exceptional for a range chimney to be wanting in draught, and, as a general and almost universal rule, this type of chimney has a draught more or less in excess of what is needed for the proper working of the range. When a want of draught is apparent at the range, it is not the fault of the kitchen chimney, except in comparatively rare cases. Other chimneys may occasionally be found sluggish, that is, with a rather slow up-draught, but the kitchen chimney is seldom wanting in this respect. However, it is a good plan to make some kind of test of this (when a range draws badly), this being done by opening the sweeping door in the covering-in plate—the high horizontal plate at the extreme top of the range opening, which closes in the mouth of the chimney—thrusting in a large handful of straw or loose paper, and lighting it. It is highly probable that this material will burn furiously and with a roaring sound, some part of it perhaps ascending the chimney. This indicates a good draught. It is also possible to form an opinion by opening the door in the covering-in plate just referred to—opening it just a little and holding the flame of a candle there and seeing how the draught draws the flame through the narrow opening. The straw or paper test, however, makes the strength, or poorness, of the draught more obvious and convincing.

If a range appears to fail through want of draught, it is plainly a case of the chimney draught not pursuing a proper course through the range. There is a waste or loss somewhere, or else the flue passages in the range are choked.

Choked Flue Passages.—Taking this defect first as being the more easily dealt with, the choking of flue ways round a range may be due to narrow construction, but this is very rarely the case, and if a stoppage exists it will probably be due to a collection of soot or debris fallen down the chimney, or a displaced brick. Any of these can be readily traced, as a rule, and the obstacle cleared away.

Air Leakages.—The more common and quite general cause of sluggish draught in or through a range, when there is a good draught in the chimney, is the existence of leaks in the form of fissures, holes or unsound places around or in the range.

What may be considered as a golden rule in fixing all close-fire ranges or kitcheners is to *ensure that all the draught that enters a chimney shall first go through the fire.*

There is a sufficient and constant draught in the chimney, and the air of which the draught is composed comes from the kitchen; therefore, ensure that it takes one route only, this being to enter the front or bottom of the fire-box of the range, thence through the burning fuel into the flues, and then to the chimney. There must be no cracks or ill-fitting places around the range, no missing flue doors or holes by which air can get to the chimney without going through the fire.

It will be understood that the design of a modern range or kitchener requires a good draught to operate it. The ovens and hot-plate require the flames and heated gases to travel quite horizontally from the fire along the top of the oven; then they have to pass downwards, descending the outer side of the oven, then horizontally

again under the oven, before they ascend to the chimney. This is all contrary to what the flame and heat would do naturally, and a keen current of air of some strength is necessary to carry flame, gases, and smoke swiftly round the ovens as is necessary.

To discover leaky places, a candle-flame can be held at any suspected spot, and it will at once be seen if air is passing in by its carrying the flame with it. These leaky places may have come since the range was fixed, or may have been left by the fixer —for fixers do not always understand the necessity of making everything air-tight. The common places are up each side of the range, between range and mantel jambs, also around the covering-in plate at the extreme top. Sometimes the door in this plate fits badly, while occasionally a flue door in the lower part of the range is missing. In any case, the leaks must be discovered, and then be stopped.

About the worst case of leakage, and entailing the most work to remedy, is when the brickwork at the back of the range—that forming the brick-flues—is beginning to perish. The brickwork around and between the flue passages is intended to prevent flue from leaking into flue, also to keep the flues sound with the metal parts of the range. In course of time the heat causes the brickwork to perish somewhat and to become unsound, and then one remedy is to take down the back plates of the range—the covering plates—and re-bed them on the brickwork with mortar. When these plates are down it will be seen if something further must be done; whether, for example, the range must be re-set with new brickwork. The latter is a last resource, and not often necessary.

Surplus Draught.—It may occur to some that they have seen ranges doing good work although there has been obvious air leakage, and this, when it happens, raises a doubt as to the necessity of sound fixing. As mentioned earlier, the draught in a kitchen chimney usually exceeds that required by the range, more or less, and the writer has on several occasions seen ranges cooking properly although the leaks have been such as would be fatal to most ranges. It simply amounts to this—that when the chimney draught is very excessive in strength and volume, the range can afford to lose some. This, however, is no reason for careless or leaky fixing as a general thing, and the majority of ranges are reduced in efficient working to a marked degree by quite a moderate leakage of air into the chimney. Ranges should be soundly fixed, air-tight, and if the draught is excessive the dampers—which are provided expressly to correct this—should be operated. If unsound fixing is to be allowed, who can say how much unsoundness is permissible for any particular chimney remembering that no two chimneys can have precisely the same draught in them? They all differ, by little or much, though practically all have more than what is needed.

Portable Ranges.—The portable range, requiring no brickwork and having its flues all within its own metal casing, suffers considerably by air leakage, this, of course, interfering with its efficient working. It might be thought that an iron-flued range would be free from this failing, but it is not so. Sometimes it is that the fixer, understanding that no fixing is needed in the sense that he understands fixing, is particularly careless in connecting the range with the chimney, while more frequently there is considerable leakage through the range being put together badly (if it is put together by the fixer), or having its parts shaken loose in railway transit.

It may always be assumed that a portable or self-contained range has its iron flues properly arranged as to size, direction, and area, as no one can settle such points so well as the designer and maker of the range. Consequently, if such a range does not "draw" well, it will, in nearly all cases, be due to the draught in the chimney not drawing its air through the fire-box. In other words, there is leakage or air entrance somewhere between fire-box and chimney.

Portable ranges have been seen simply placed beneath a chimney opening, with

a 3-ft. length of flue pipe to discharge smoke into the chimney, the chimney opening around the pipe being clear and unclosed. Of course, the opening must be closed in by a plate made air-tight all round its edges and the hole in the plate where the smoke pipe passes through must be a tight fit. No air must go into the chimney without first passing through the fire.

If a portable range is delivered in parts which have to be screwed on or together by the fixer, the joints where metal comes against metal require to be made sound, and the material used for such joints is ordinary glazier's putty. To make a good job, the surfaces which the putty comes against should be rubbed over with oil-

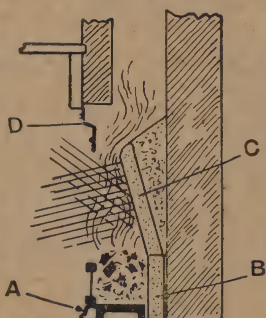


Fig. 9.—Old-style Fire Grate Converted for Slow Combustion

paint, but this is sometimes omitted. A portable range should be examined to see if all joints appear sound, and, where necessary, putty should be used to make the range an air-tight box. If a newly fixed portable range draws badly, although the fixing appears to be correct, it is then reasonable to suspect that the joints are unsound, a matter that can be quickly tested by watching the movements of a candle-flame held against them.

INCREASING EFFICIENCY OF OPEN GRATE

There still exist at the present time great numbers of fire grates of old design, contributing only a very small percentage of their heat to the room, while the larger part goes up the chimney. While there are so many varieties of modern grates on the market, all much more efficient than the old types, it will be found that the actual improvements which they demonstrate lie in two things, namely, the shape or rather the arrangement of the back-brick, and the provision of a means of ensuring slow combustion; there are minor improvements also, but chiefly in detail. If an old grate is altered, as it can be, in these two ways, it will show a most marked difference in effectiveness, and may even be made equal to some of the newer kinds.

The old register grate consisted mainly of a fire-box having a grate at the bottom, bars in front, and a brick at the back. The alteration to be suggested is to close in the space under the bottom bars by means of an iron plate or strip, in front, reaching from the lowest front bar to the hearth. This plate is known as an "economiser." The plate is shown in Fig. 9 just beneath the front bars (see A), having a knob by which to hold it. The plate is shown sloping, as is necessary to keep it in position if the front bars are quite straight, but if the bars are curved or have angle ends then an upright plate will do. The intention is to keep air from passing freely beneath the bottom bars of the grate, and in doing this—in the simple provision of this plate to close in the ash pit—a slow combustion effect is obtained.

The greater alteration, and the one that has the greater heating effect, is to provide a new back-brick. This may entail breaking away the back casting of the grate, leaving the front ornamental one only. The back is then built up with fire-bricks as shown. The lower brick B (Fig. 9) is a simple square slab 3 in. thick, standing upright, although in many modern grates it is made to slope, the back being against the wall at top, and forward about 3 in. at the bottom. It is argued that only the top and front of the fire need be of full area and the bottom may be small. Some are so small at bottom that the inner grating in only 3 in. from front to back. The most important part is the upper brick, C; it must reach up above the metal canopy or curtain, D, at the front of the

grate, and also it must overhang or lean over the fire as shown. The proper slope is 70°.

The effect of the overhanging brick is threefold. It prevents the free escape of the heat and hot gases into the chimney. It deflects much of the radiant heat from the top of the fire into the room, as indicated by the projecting lines sloping upwards; and as it becomes intensely hot, almost as hot as the fire itself, it radiates heat to a full useful extent as shown by the downward sloping lines. In this last respect, it answers the same purpose as greatly increasing the area of the glowing hot fire.

The two bricks shown do not complete the fire-box, as the sides have to be made up. These may be built up in fire-bricks (right from bottom to top) or they may be fire-brick slabs cut to shape. To be correct, these should be quite upright, but slope from front to back at an angle of 45°. It does not matter very greatly. however, whether the sides are at right angles to the front. or whether they are splayed as suggested. The splay is best, as it makes the fire-box of a little better shape; that is, wider at front than at back, and keeps it at a little more economical size if the room does not require a big fire. Fire-clay slabs of various shapes, and suitable for this purpose can be obtained at most oilshops.

KEEPING FIRES ALIGHT UNATTENDED

In bedrooms occupied at night by invalids or aged people or in day-rooms which are only occupied for short periods, with empty hours between it is a great convenience to be able to keep the fire alight for a fairly long period without attending to it. The earliest successful attempt at reducing the speed of combustion of fire grates (without noticeably interfering with their efficiency as heaters) was by preventing all air passing under the fire-box and up through the bottom bars. The original plan was to do away with the bottom bars, and let the fuel rest on a fire-brick base, but more recently the bottom bars have been used again, and an iron plate or casting is arranged to close in the front of the ashpit, and so produce the same result. It must be emphasized that, to get slow combustion, air must be prevented from passing under the fire and up through the bottom bars.

The plan about to be described, for getting a still slower rate of combustion, is simply to apply the same principle somewhat farther; this being *to close off the front cf the fire as well as the bottom*, so that air cannot either enter bottom or front of the fire, but only pass over the top of it. Fig. 10 shows an ordinary type of fire grate, with, below, a bent piece of sheet iron, with knob or handle. The iron is of such a shape that it may be stood in front of the fire to close the front from the top fire bar down to the hearth, and when this is done, it prevents air passing through the front or bottom or the fire. The plate should fit as accurately as possible.

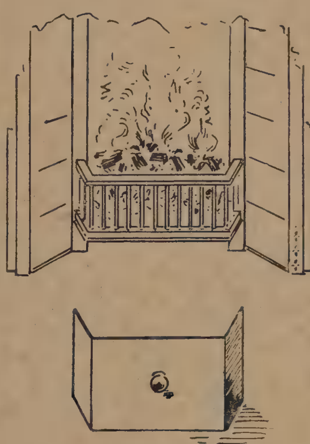


Fig. 10.—Fire Grate and Plate for Ensuring Slow Combustion

Assuming that a fire is burning in the grate, it can be made up with fuel level with the top bar (for little is gained by piling it up higher than this); then the plate is stood in front and the fire left to take care of itself. The writer has known a great many instances where a fire so left has kept alight twelve hours without attention, and after this period the fire has been quite worth calling a fire. not a few hot cinders. It does seem as if combustion can be very nearly stayed by this means, yet the fire does not go out, and

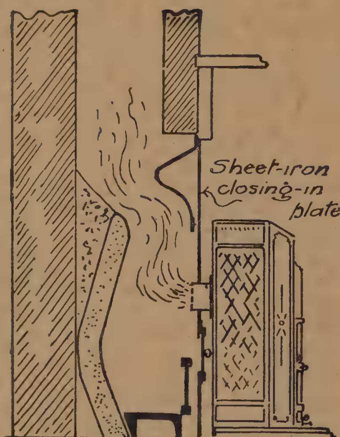
gives off appreciable warmth all the time.

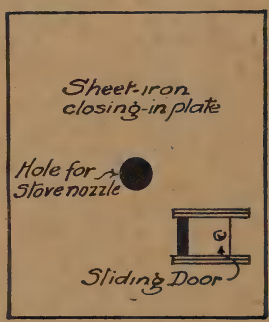
FIXING AN ANTHRACITE STOVE

In fixing an anthracite stove, there is one rule to be observed that is common to all stoves, this being to give it the chimney to itself, and to connect it to the chimney in an air-tight manner. It is requisite to work to the rule that all the air that goes into the chimney must first go through the fire, and not find leaky places or crevices due to unsound fixing through which it can get to the chimney without passing through the fire. This rule will, however, be qualified a little farther on but as regards the actual fixing this rule must be observed.

Fig. 11 shows in section from front to back the fixing of an anthracite stove in front of an existing fire-grate. It will be seen that the mantelpiece opening is closed in—covering the whole of the fire-grate—with a sheet-iron closing-in plate, which should fit soundly everywhere, the hole for the stove nozzle being cut to fit accurately. This gives the air-tight fixing as recommended but it is found with this class of stove that provision should be made to give an air-leakage into the chimney, provided the leakage is under accurate control. This is arranged for by the opening with sliding-door, shown in Fig. 12, and in section in Fig. 11.

The anthracite stove is made to take a charge of fuel to last many hours without attention, and to admit of this, it is fitted with a proper draught damper, which controls the air passing through the fire. But not infrequently due to a little strain, which the stove may receive in transit or from some other cause, the doors and parts of the stove are not as air-tight as they should be, and if the whole pull of the draught in the chimney is felt on the stove the fire will burn at high speed, notwithstanding that the damper in the stove may be closed. By means of the hole and sliding-door in the closing-in plate, the draught of the chimney can be adjusted to suit the stove.





Figs. 11 and 12.—Cross Section Through and Part Elevation of Fireplace with Fixed Anthracite Stove, Showing Closing-in Plate, etc.

It follows that if the sliding door is open a certain proportion of the air passing up the chimney—the draught—will pass through this hole while the proportion passing through the stove will be reduced accordingly. It is thus easy to adjust the stove draught with some nicety, while still leaving it possible for the fire to be hastened or checked by the stove damper. The sliding-door takes the excessive share of the draught, leaving the stove with that which may be termed normal. The working of anthracite stoves is thus improved, in fact perfected, by this means.

Another use for the sliding-door—if the chimney draught is more than the stove needs, and will permit of the door being opened—is to increase the ventilation of

the room. If all the air removed from a room passes through an anthracite stove working with its damper closed down to a slow draught, as is usual, the amount of air so removed will be very small and probably insufficient for a room occupied by two or three people. The average chimney is an excellent extract ventilator, but not if it is almost closed at the point where it starts from the room. With the sliding-door open, the ventilation will probably be equal to that obtained with on open fire-grate. The hole, when the door is fully open, might be 6 in. by 6 in.

If an anthracite stove is to come over a wooden floor, there should be a slab of 2-in. stone, or an iron tray upside down, for the stove to stand upon.

Repairing Marble Top of Washstand

In the following method of repairing a broken white marble washstand top no special tools are necessary, and the top can be made, to all appearance, quite as strong as before the fracture; but it is important to effect the repair right angles to the break, as shown in Fig. 1. The pieces are carefully fitted together, and two parallel pencil lines ruled for each cramp, the lines being $\frac{1}{4}$ in. apart and about 1 ft. long. The cramps are prepared from wire nails 4 in. long,

Fig. 1.—Riveted Marble Slab

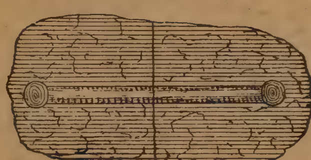


Fig. 3.—Cramp in Position

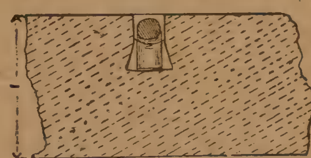


Fig. 4.—Section Showing Cramp in Position

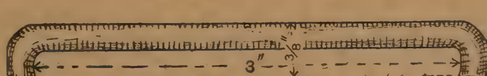


Fig. 2.—Cramp or Rivet

before the broken edges have been subject to further damage.

Fig. 1 shows the under-side of the slab, which is 3 ft. 6 in. long by 1 ft. 7 in. wide. Lay the slab on a perfectly level surface, and protect it with a sheet of stout brown paper. A table or bench will be suitable if the top is quite true. Three cramps will be required, each fixed at $\frac{3}{16}$ in. in diameter, from which the head and point are cut off with a cold chisel. The nails are softened by heating in a red fire and allowing them to cool, and then bent to shape as in Fig. 2, making the bends as square as possible.

When the cramps are ready, holes are marked as in Fig. 3, and drilled with a brace and an old reamer, using a little

water to lubricate. The inside edges of these holes are kept slightly over the 3 in. apart, so that to insert the cramps it is necessary to expand them by heating (to black heat only), and then gently tap into position with a hammer. An old flat 10-in. file may be used for cutting out the chases for the cramps to lie in, turning the broken edge of each piece of marble to the front of the bench and filing between the pencil marks, stopping at the drilled holes. When all these chases are prepared, the two pieces of marble are again laid in position, the cramps heated, and gently hammered in. An enlarged section across one of the cramps is shown in Fig. 4. All is now filled up level with plaster of paris, and left to set and harden for a couple of days. The slab is then turned over, and a little plaster of paris rubbed into the crack on the right side.

No plaster of paris should be put in the joint, or it will not close up properly, and, in time, plaster will show as a dirty line.

For coloured marbles a little patent knotting (shellac dissolved in methylated spirits) can with advantage be applied to the break just before joining. This is a useful tip when repairing smaller pieces, such as mantel jambs.

Cleaning and Preserving Leather Bags

Restoring Colour of Brown Bags.—To restore the colour of a tan-leather bag which has faded, wash it well all over with a soft brush, warm water, and soap. Then wash again with clean water, and, while wet, sponge it well all over with one pennyworth of oxalic acid to a gill of water, and continue to rub this in until all the stains are out. To give a darker colour to the bag, use a weak solution of ammonia and water. When this is quite dry, it can be well creamed with any colour desired. To make it look bright, somewhat like brown patent, give it a very thin coat of leather varnish. This must be put on with a very soft brush, and passed over very evenly and smoothly.

Restoring Colour of Black Bags.—A leather hand-bag that has worn brown can be blackened by sponging it with warm soda water, somewhat strong, but used sparingly, and then, when it has soaked in, applying a coat of good black ink. When this is dry, sponge it again and give it another coat of ink. When the above has dried in (if it does not need another coat), rub off all surplus ink with a damp cloth and apply a coat of stale white of egg; an extra coat of this now and then will keep the bag in good preservation. If it can be obtained, use bookbinders' varnish instead of the egg.

Removing Ink Stains.—To remove ink stains from brown leather, make a solution of 1 part of oxalic acid in 10 parts of water; touch the stain with this until it is removed, then wash off with water, dry, and rub up with a little brown-leather polish. There is no way of removing ink stains from brown leather without leaving a lighter shade at that particular place. In the trade, the method usually adopted, if ink stains should get on the leather, is to cover the stains with oxalic acid and then re-colour the whole of the leather with saffron and annatto, which must be a deeper dye than the original.

Renovating Sheepskin Bag.—In renovating a black, dull sheepskin bag, first wash it with a sponge and warm water to remove all dirt and grease; then with a sponge saturate the leather with black dye, obtainable from a grindery shop; when dry, wipe over with an oily rag. Treat the surface carefully, or the face of the leather will peel off. If the bag is of black morocco, wash and dye as before, but instead of using oil get some "Empire" gloss; place a small portion on a boot brush, and rub the leather briskly.

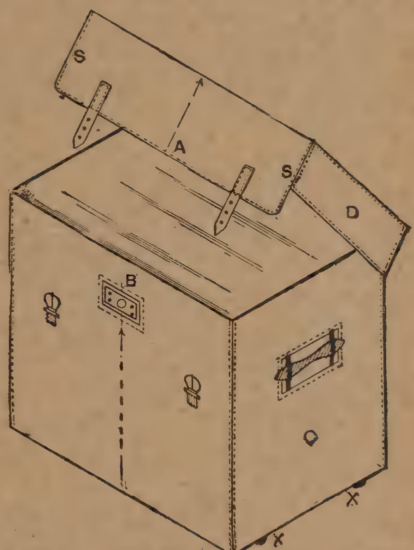
Renovating Morocco Bag.—If the bag is of black polished morocco or hide, wash and dye as before, and when the leather is dry warm it, and with a dry sponge or brush apply lightly some special leather varnish.

Waterproofing Canvas Trunk.—A travelling trunk covered with coarse tan-coloured canvas may be waterproofed as follows: Make up a liquor of 1 lb. of yellow soap dissolved in $\frac{1}{4}$ gal. of hot water. Add to this $\frac{3}{4}$ gal. of boiled oil and $\frac{1}{4}$ gal. of turpentine. Mix well together, and apply two coats. When thoroughly dry, apply a third coat in which about twice its weight of dark brown oxide or lampblack ground in oil has been well stirred. This may now be coated over once or twice with very hard black japan slightly thinned with turpentine, or more cheaply with a good paint thinned with best copal varnish and turpentine. A flat dull surface will be most satisfactory for the lettering, which can be japanned round or varnished over afterwards; use white zinc thinned with crystal varnish for the lettering.

Making a Portmanteau Cover.—As a protection for a new bag or trunk, or as a means of concealing the shabbiness of an old one, there is nothing better than a waterproof canvas cover or case. The illustration shows the portmanteau with the cover on.

A cover for a portmanteau measuring 30 in. by 28 in. by 19 in. may be got out of $2\frac{1}{4}$ yd. of 60-in. canvas by making a seam at the bottom between the battens X. If this is not done, it will take 3 yd. Cut the material down the centre. From one half cut off a piece 70 in. long; from the other half cut a piece 36 in. long. By stitching these together they will be long enough to reach from A to B, and the seam will lie just within the battens near the front one. The two corners on the flap A must be rounded off, and the other end at B turned in and stitched or stuck down with solution. Cut out the space for the lock, and stitch a binding round it. Two pieces will be required for the ends C; these must each be cut 30 in. by 20 in.

Cut out the spaces for the handles, and turn in the top edge as at B. The handle spaces must be bound round with thin leather, and so must the flap piece from S to S, and the bottom of each piece marked D. These should be cut $20\frac{1}{2}$ in. by 5 in.



Canvas Cover for Trunk or Portmanteau

or 6 in., the depth extending below the lid. Stitch two buckles with chapes and loops on the front as shown, and then proceed to fix the various pieces in position on the portmanteau. Draw them tightly in all directions; see there are no wrinkles, and fix them by basting the edges together. To go round the edges thus formed, put a good basil or thin hide binding $\frac{3}{4}$ in. wide in order to cover the basting stitches and take in sufficient material to prevent the edges fraying out. Two straps 9 in. by 1 in. are then stitched on to the top flap and the cover is finished.

Micrometers: How to Make and Use Them

Typical Micrometers.—When accurate dimensions are required in the working of metals, instruments such as rules, callipers, etc., are of no use, and much more delicate means must be employed. With the same pair of callipers, for example, two men might obtain measurements differing by as much as ·002 in. or even more. The "personal equation" exists, but is not such a serious factor, in using a micrometer, the ordinary form of which, for measuring from 0 in. to 1 in. by thousandths, is illustrated by Fig. 1. This instrument is fitted with a locking ring A, which is given half a turn to prevent the moving of the spindle when measuring articles of the same size. It will be understood that the measurements are made in the gap B, between the end of spindle C and the anvil D.

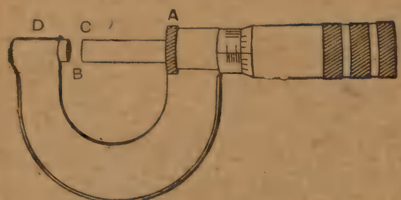


Fig. 1.—Ordinary Micrometer

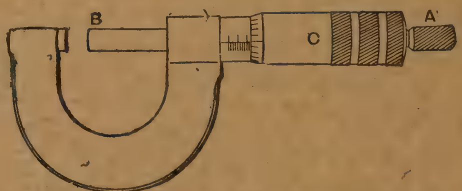


Fig. 2.—Micrometer with Ratchet Stop

To prevent injury to the instrument when in use, and also to enable similar dimensions to be obtained by several persons, a ratchet stop is fitted to many micrometers, as shown at A (Fig. 2). When this tool is being used, the spindle B is screwed forwards by revolving the ratchet by means of the finger and thumb; immediately the spindle touches the article being measured, the ratchet slips and does not allow the spindle to be strained. Another advantage is that the spindle can be screwed in or out more rapidly by turning the ratchet stop A than by turning the barrel. For instance, the spindle may perhaps make one revolution each time the thumb and finger is moved; this would not be so with the barrel C.

Micrometer screws are rarely made longer than 1 in., and in order to enable a micrometer to measure more than 1 in., an ingenious method, shown clearly by Fig. 3, has been devised. When this instrument is being used for measuring from 0 in. to 1 in., the sliding bar A is in the position shown; but when measuring from 1 in. to 2 in. the sliding bar is pulled out after releasing the screw B. In order that the tool can be set correctly, a test

piece C, which is exactly 1 in. in diameter, is provided. After pulling out the piece A, the test piece is inserted between the measuring points; and when the micrometer registers at zero with the test piece

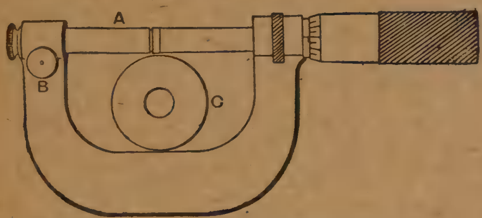


Fig. 3.—2-in. Micrometer

between the points, the screw B is tightened up and the test piece removed. The instrument can then be used for measuring articles from 1 in. to 2 in. in diameter.

The type of instrument shown by Fig. 4 is used for measuring large diameters, the screw only having a movement of 1 in. Standard-length bars A are provided in order that the accuracy of the instrument may be tested.

An improved micrometer provided with a finger ring is shown by Fig. 5. This tool can be held in one hand, and this method renders it easy to use.

The inside micrometer shown by Fig. 6 is similar in construction to an external micrometer, the difference being in the position of the measuring points A and B. A disadvantage of this design of instru-

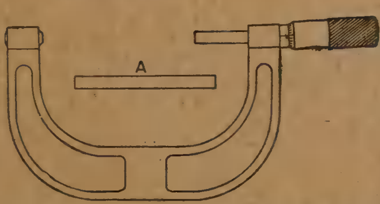


Fig. 4.—Micrometer for Large Diameters

ment is that small holes cannot be measured, owing to the thickness of the points.

How to Read a Micrometer.—In the micrometer shown by Fig. 7, the spindle A is attached to the thimble B at the point C, and the part of the spindle which is concealed within the sleeve is threaded to fit a nut in the frame D. The frame being held stationary, the thimble B is revolved by the thumb and finger, and the spindle, being attached to the thimble, revolves with it, and moves through the nut in the

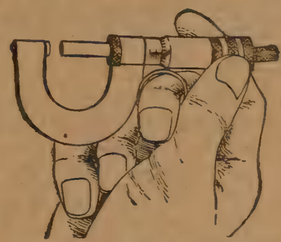


Fig. 5.—Micrometer with Finger Ring

frame approaching or receding from the anvil E according to the direction of rotation.

The article to be measured is placed between the anvil E and the spindle A, and the measurement of the opening between the anvil and the spindle is shown by the lines and figures on the sleeve D and the thimble B.

The pitch of the screw threads on the concealed part of the spindle is 40 to one inch, therefore one complete revolution of the spindle moves it longitudinally one-fortieth (or twenty-five thousandths) of an inch. The sleeve D is marked with forty lines to the inch, corresponding to the number of threads on the spindle. When the micrometer is closed, the zero line on the thimble coincides with the line which is marked 0 on the sleeve, and

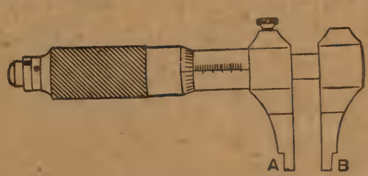


Fig. 6.—Internal Micrometer

the zero line on the thimble agrees with the horizontal line on the sleeve.

Open the micrometer by revolving the thimble one full revolution, or until the 0 line on the thimble again coincides with the horizontal line on the sleeve. The distance between the anvil E and the

spindle A is then $\frac{1}{40}$ in., or ·025 in., and the bevelled edge of the thimble will coincide with the second vertical line on the sleeve. Each of these lines indicates a distance of $\frac{1}{40}$ in. Every fourth line is made longer than the others, and is numbered, 0, 1, 2, 3, etc., each indicating a distance of $\frac{1}{10}$ in. The bevelled edge of the thimble is marked in twenty-five divisions, and the fifth lines are numbered 5, 10, 15, 20 and 0. Rotating the thimble from one of these marks to the next, moves the spindle longitudinally $\frac{1}{25}$ of twenty-five thousandths, or one-thousandth of an inch; rotating it two divisions indicates two thousandths, etc. Rotating from zero to zero, through 25 divisions, makes a complete revolution, which, as will be seen, is ·025 in. or $\frac{1}{40}$ in.

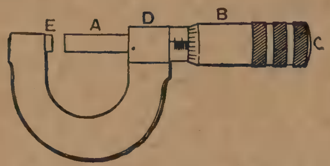


Fig. 7.—Micrometer Set for ·178 of an inch

To read the micrometer, multiply the number of vertical divisions visible on the sleeve by 25, and add the number of divisions on the bevel of the thimble from 0 to the line which coincides with the horizontal line on the sleeve. For example, as the instrument is shown in Fig. 7, seven divisions are supposed to be visible on the sleeve. Multiply this number (7) by 25, and add 3, the number of divisions shown on the bevel of the thimble. The micrometer is open to one hundred and seventy-eight thousandths (7×25=175+3=·178).

Fig. 9.—Thimble and Barrel Graduations

The Graduation Explained.—The readings in ten-thousandths of an inch are obtained by means of a vernier (so called from the name of its inventor) or series of divisions on the barrel A of the callipers as shown in Fig. 8. These divisions are ten in number, and occupy the same space as nine divisions on the thimble B; for convenience in reading they are figured 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. The "0" is zero and "10." When a line on the thimble coincides with the first line of the vernier, the next two lines to the right differ from each other one-tenth of the length of a division on the thimble; the next lines differ by two-tenths, etc. Fig. 9 shows the graduations on barrel and thimble enlarged.

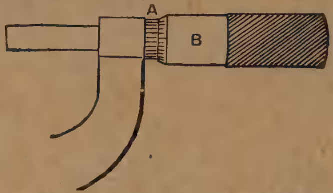


Fig. 8.—Barrel and Thimble of Micrometer

When the micrometer is opened, the thimble is turned to the left, and when a division passes a fixed point on the barrel it shows the micrometer has been opened one-thousandth of an inch. Hence, when the thimble is turned so that a line on the thimble coincides with the second line (end of the first division) of the vernier, the thimble has moved one-tenth of the length of one of its divisions, and the micrometer opened one-tenth of one-thousandth, or one ten-thousandth of an inch. When a line on the thimble coincides with the third line (end of second division) of the vernier, the calliper has been opened two

Fig. 10.—Vernier Reading for ·0003 in.

ten-thousandths of an inch, etc. In Fig. 10 a line on the thimble coincides with the fourth line (end of third division of vernier), and the reading is three ten-thousandths of an inch.

To read the micrometer, note the thousandths as usual, then the number of divisions on the vernier, commencing at 0, until a line is reached with which a line on the thimble is coincident. If it is the second line, figured 1, add one ten-thousandth; if it is the third line, figured 2, two ten-thousandths, etc.

Micrometers graduated to ten-thousandths should not commonly be used where fine measurements are not required, as in an instrument of this class it is important to avoid wear, which would be of comparatively slight consequence in a calliper that reads only to thousandths.

Heat Effect when Using Micrometers.—An interesting experiment to prove the expansion of metals may easily be made with the aid of a micrometer. A piece of iron or steel, either of circular shape or in the form of a bar, can be measured so that it easily slips between the micrometer points, but yet touches both of them. The micrometer should now be laid aside for a short time, care being taken that the spindle is not moved, and the piece of iron or steel held in the hand for, say, five minutes. It will then be found that the piece of metal will not go between the points without forcing, and if a long bar has been used it cannot even be forced between the points. Now, if the bar is immersed in some cold water for a few seconds, it will easily pass through. It thus follows that when extremely accurate measurements are required, care must be taken to keep the articles at a normal temperature while being finished. In most engineering shops the article being made is constantly placed in water, which is kept at a certain temperature. This enables good results to be obtained.

In the manufacture of delicate measuring instruments the room in which they are made is kept at an even temperature and the workmen wear thick felt coverings in order to keep the heat of the body from the work.

Reading Vernier Calliper.—Fig. 11 shows the end of a vernier calliper and the scale or vernier on a Brown and Sharpe internal micrometer or vernier calliper (see Fig. 6). On the bar of the instrument is a line of inches numbered 0, 1, 2, etc., each inch being divided into ten parts, and each tenth into four parts, making forty divisions to the inch. On the sliding jaw is a line of divisions of twenty-five parts, numbered 0, 5, 10, 15, 20, 25. The twenty-five parts on the vernier correspond, in extreme length, with twenty-four

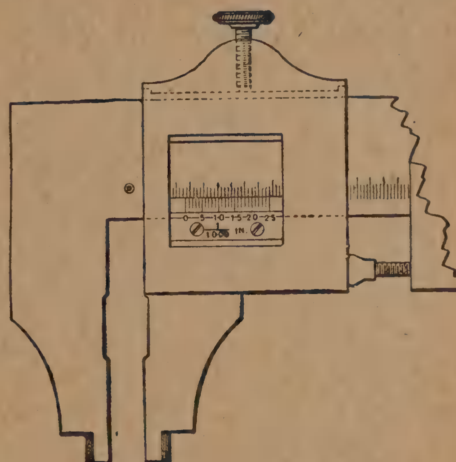
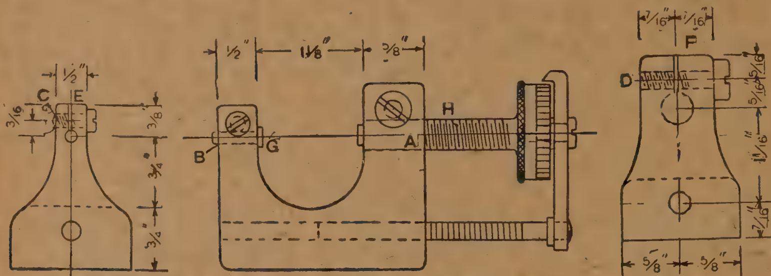


Fig. 11.—End of Vernier Calliper

parts, or twenty-four fortieths of the bar; consequently each division on the vernier is smaller than each division on the bar by ·001 in. If the sliding jaw of the calliper is pushed up to the other, so that the line marked 0 on the vernier corresponds with that marked 0 on the bar, then the next two lines to the right will differ from each other by ·001 in., and so the difference will continue to increase ·001 in. for each division, until they again correspond at the line marked 25 on the vernier. To read the distance the calliper may be open, begin by noticing how many inches, tenths, and parts of tenths the zero point on the vernier has been moved from the zero point on the bar. Now count on the

vernier the number of divisions, until one is found which coincides with one on the bar, and this will be the number of thousandths to be added to the distance read off on the bar. The best way of expressing the value of the divisions on the bar is to call the tenths one-hundred thousandths (·100), and the fourths of tenths, or fortieths, twenty-five thousandths (·025).

Making a Micrometer.—A good micrometer can be made without much trouble, provided that a lathe and a drilling machine are available. The instrument shown by Figs. 12 to 14 will give accurate results to ·001 in. An end view of the pointer is presented by Fig. 15. The body can be made from a piece of cast-iron or mild steel; if the former, a pattern is



Figs. 12 to 14.—Three Elevations of Home-made Micrometer

Fig. 15. — End Elevation Showing Pointer

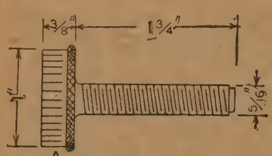


Fig. 16.—The Measuring Screw

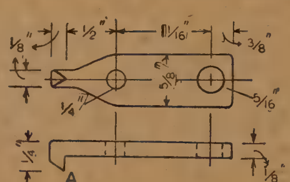


Fig. 17.—Guide Finger

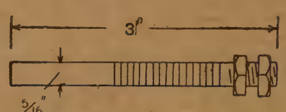
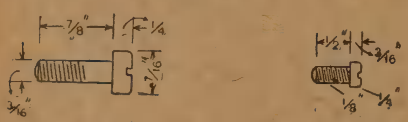


Fig. 18.—Guide Bar



Figs. 19 and 20.—Clamping Screws

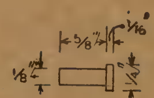


Fig. 21.—Pad or Anvil

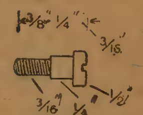


Fig. 22.—Screw for Guide Finger

Referring to Fig. 11, it will be seen that the jaw is open two-tenths and three-quarters, which is equal to two hundred and seventy-five thousandths (·275). Now suppose the vernier was moved to the right so that the tenth division should coincide with the next on the scale; this will make ten thousandths (·010) more to be added to two hundred and seventy-five thousandths (·275), making the jaws to be open two-hundred and eighty-five thousandths (·285).

necessary, and if the latter, a forging. Mild steel makes a better instrument, but gives more trouble in working. The hole A (Fig. 12) is carefully drilled and tapped with a tap having forty threads per inch, and which is $\frac{5}{16}$ in. in diameter over the top of the thread. The hole B is drilled $\frac{1}{8}$ in. in diameter, and carefully reamered to a smooth finish; the hole C (Fig. 13) is tapped $\frac{1}{8}$-in. Whitworth or $\frac{1}{8}$-in. fine thread; and the hole D (Fig. 14) is tapped $\frac{3}{16}$-in. Whitworth. The saw cuts E and F

(Figs. 13 and 14) are to enable the pad or anvil G (Fig. 12) and the screw H to be gripped when taking up wear. The hole for the sliding guide piece is $\frac{5}{16}$ in. in diameter, and should be very carefully and smoothly finished.

The measuring screw (Fig. 16) should be made from a piece of cast steel, and threaded forty threads per inch. Great care is necessary in finishing this screw, and smooth threads are desirable. The head A requires to be marked round its periphery with twenty-five divisions, in order to be used for ·001 in. measurements. A milled edge is also provided to enable it to be easily turned with the fingers. The screw having forty threads per inch will thus advance $\frac{1}{40}$ in. every revolution. Therefore, if it is turned one-twenty-fifth of a complete revolution, it will advance $\frac{1}{1000}$ in., since $40 \times 25 = 1{,}000$.

The guide finger (Fig. 17) is made of mild steel, and the point A is hardened after first being carefully filed to a knife edge. The arrangement of this can better be understood from Figs. 12 and 15.

The guide bar (Fig. 18) should be turned from cast steel, and threaded at one end to take two nuts, which grip the lower portion of the guide finger. The marks seen in the illustration are $\frac{1}{16}$ in. apart, and they are used for approximately obtaining the distance apart of the measuring points. These marks should be put on the bar after the instrument has been put together.

The screws (Figs. 19 and 20) should be made from ordinary mild steel, or, better still, cast steel. The pad or anvil (Fig. 21) should be of cast steel, and afterwards hardened. The guide-finger screw (Fig. 22) fits into the head of the measuring screw, and carries a small washer to prevent the guide finger binding when the screw is being revolved.

When all the parts are finished, they should be placed in position, using fine emery-powder and oil, especially so in the case of the screw. This should be continually worked to and fro until all roughness disappears and a smooth action is obtained. Traces of emery must be removed from all parts after they are fitted. As wear takes place the screws must be carefully adjusted with a screwdriver; and if the points do not come together accurately when the pointer is exactly on the zero mark, the loose pad (Fig. 21) must be adjusted. After completion, and if the instrument is not in use, it should be kept in a specially made box in order to prevent any damage resulting from knocks, etc.

Making an Ottoman Chair from a Cask

A QUAINT and cosy ottoman chair, as shown by Fig. 1, can be made from a 9-gal., 18-gal., or 36-gal. cask. First draw a line round just below the centre of the cask, and then one on each side from this line to the top of the cask, thus dividing it into halves. Then with a hammer knock off the two top iron bands, and take out the top. Saw down the line at each side to the one below the centre, which is the height of the seat, and then along the seat line. The two iron bands that have been removed must be cut into two, and one-half of each nailed or screwed in its original position. The two other bands will also require nailing to ensure them keeping their position.

The seat must be made removable, so that the well serves as a receptacle for

papers, etc. A simple and effective way of doing this is to screw five or six blocks on the inside of the cask, the thickness of the seat below the sawn edge (see Fig. 2). These blocks are of hardwood, say oak or birch, about $3\frac{1}{2}$ in. long by 2 in. wide; and as there will be considerable weight on them, they should not be less than $\frac{3}{4}$ in. thick. The seat is best framed together with a panel in the centre; but if this is too difficult, it can be cut to shape from $\frac{5}{8}$-in. grooved-and-tongued boards, two clamps being screwed to the under-side.

Fig. 1.—Ottoman Chair made from Cask

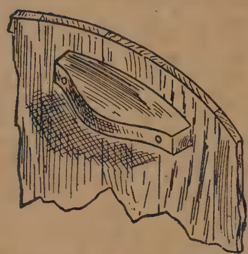


Fig. 2.—Seat Support

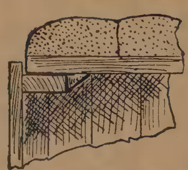


Fig. 3.—Section Through Part of Seat

Fig. 4.—Cask-chair Covered with Cretonne

The whole of the cask inside is padded down to the seat, as also is the seat. To do this the surfaces are first covered with stout canvas or sacking stretched and fixed with tacks round the edges. The flock or hay padding is then well filled in, and the whole covered with cretonne or american cloth. The outside covering of the seat is brought right over the edges and tacked to the under-side of the boards, as will be seen enlarged in Fig. 3. If the back and the seat are stabbed at intervals, and buttons sewn on, it has a very good effect.

The exterior of the cask should now be thoroughly scraped and smoothed with glasspaper, and, if the cask is in good condition, with the wood nicely figured, it should be polished; otherwise it is best painted and varnished. The colour, of course, should be one that will harmonise with the material with which the seat and back are covered.

Instead of the chair resting solidly on the bottom, it is desirable to screw four blocks of wood to the under-side, to which casters can be fastened, which make the chair easier to move about.

Another style of chair (Fig. 4) could be made by covering the whole of the outside of the cask with canvas, and then fixing neatly pleated cretonne all round, finishing off the edges with fancy brass or copper-headed nails.

Magnetos: Their Adjustment and Repair

This chapter will deal with the adjustment and repair of the modern high-tension magneto, a machine which in its most popular form works upon the principle of magneto-electric induction and provides the high-tension current that produces, in the cylinder of a petrol, oil, or gas engine, a spark between the points of the ignition plug. This spark ignites the charge of explosive gas, and the consequent expansion of the gas drives out the piston and allows of useful work being done. The magneto is itself driven by the engine to which it is attached, the supply of high-tension current being thus automatic as long as the engine is working, and the mechanism functioning correctly. The majority of motor-cars, motor-cycles, and up-to-date stationary internal-combustion engines are fitted with a high-tension magneto, in place of the accumulator-coil or dry battery-coil or low-tension magneto-coil system formerly universal.

When a fault develops in a magneto, there are, unfortunately, no symptoms from which the probable cause of the trouble can be deduced. The machine suddenly ceases to function, or it functions irregularly (which is almost as bad), and that is the beginning and end of the matter as far as outward indications go. The trouble may be serious or it may be trivial, but in any case only by a knowledge of the machine can it be put right, and the object of this chapter is to show the possible causes of a fault and their remedies.

Working Principle.—A brief description of the component parts and wiring of the magneto will be given in order that the construction of the whole may be realised. No special make or type of magneto is referred to here, the underlying principle being the same for all magnetos working on the magneto-induction principle; but for convenience, as being the type most widely used, it is assumed that it is a four-cylinder of the usual kind. Variations occur in different makes as regards details, such as contact-breaker, disposition of condenser, etc., but they only require a little study. (In Fig. 1, p. 268, showing the construction of a typical magneto—the Watford "six-cylinder"—all the parts have reference numbers, which are explained in the list of parts printed on the same page.) Electrical knowledge though of assistance will not be necessary for the carrying out of the instructions here given if those instructions are implicitly followed.

The high-tension magneto consists essentially of four main parts, namely, the field-magnets, the armature, the condenser, and the contact breaker. Some means also must be provided for drawing the current from the rotating armature winding, and this is done via an insulated ring mounted on the armature shaft. The field-magnets vary with the type and design of the magneto. They are constructed of a special steel of great hardness, therefore no attempt should be made to file or drill

LIST OF REFERENCES

A-15, ball bearings; A-W, armature winding; C-F, cable fairways in distributor block; F-S, fulcrum stud for contact-breaker lever; S-G, safety gap; S-R, stiffening rib on contact-breaker lever; S-7, ball bearing for distributor spindle; 3, pole shoes; 5, ball race plate (with fitting for cam cage); 7-E, distance piece between ball bearings on distributor spindle; 7-F, lock nut for ball bearings on distributor spindle; 7-I, base for distributor bearing; 7-J, cap for ditto; 20-J, platinum screw for types; 46, steel collar on end of No. 40; 51-A, brass washer under ball bearing on No. 39; 52-A, steel base washer (on slip-ring) for No. 52-B; 52-B, steel dished spring washer; 57-A cap (to cover lubricating and sight holes); 63, distributor gear-wheel; 64-I, carbon-brush (for distributor rotor arm); 65, high-tension pick-up; 66, magnet; 67, dust cover; 67-A, cap (to cover lubricating hole); 67-D, felt packing strip; 68, control lever; 69, end-plate (driving end); 72, dust cover over armature,

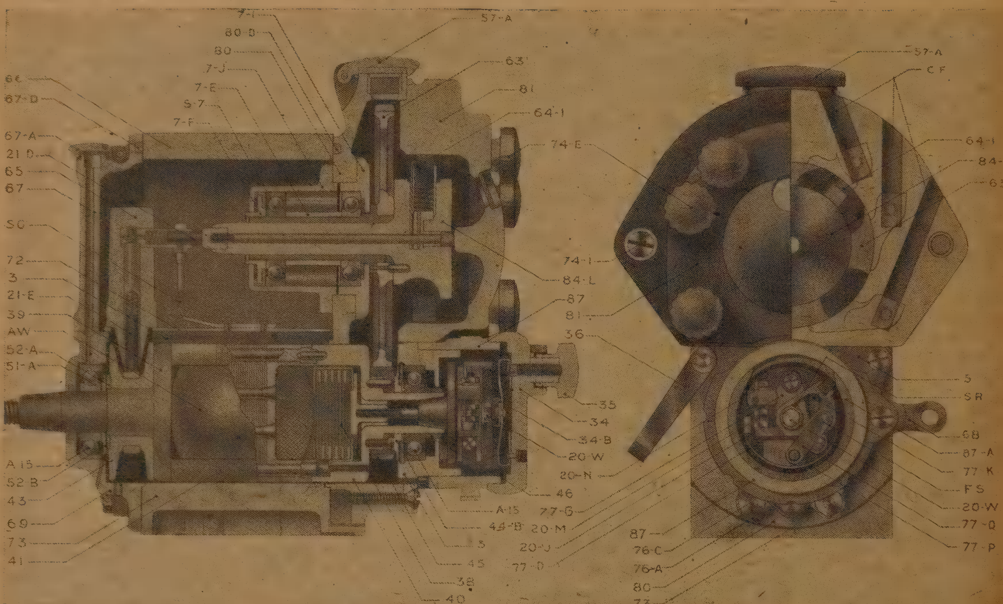


Fig. 1.—Parts of a Typical High-tension Magneto

lever; 20-M, platinum screw for screw carrier 77-G; 20-N, lock nut for platinum screw 20-M; 20-W, bolt (4 *B.A. thread*) for holding contact-breaker on to magneto; 21-D, carbon-brush for pick-up (to distributor arm); 21-E, carbon-brush for pick-up (from slip-ring); 34, inspection cover for contact-breaker; 34-B, short-circuiting terminal, complete; 35, terminal knob; 36, stud with spring for holding No. 34; 38, complete condenser; 39, driving spindle and disc; 40, brass armature end with recess for condenser; 41, armature core; 43, slip ring; 44-B, brass washer under ball bearing on No. 40; 45, 33 T pinion for 6-cylinder with stamping for safety gap; 73, base-plate, 74-E, terminal screw with insulated head; 74-I, fixing screw for distributor block; 76-A, nut (2 *B.A. thread*) for clamping rod; 76-C, clamping rod; 77-D, contact-breaker base-plate (left hand); 77-G, contact screw carrier (left hand); 77-K, contact-breaker lever; 77-Q, spring for end tension on lever bush; 77-P, return spring for lever; 80, end-plate (distributor end); 80-D, felt packing strip; 81, distributor block; 84-L, distributor rotor arm; 87, cam cage; 87-A, cam for operating contact-breaker. This is a magneto for a six-cylinder engine.

them, for it would only result in failure. The field-magnets fit over the pole pieces, which, when the magneto is erected, form a tunnel in which the armature revolves. The armature is in the form of a cylinder which has a broad channel on two opposite sides, and is therefore roughly of H section. The ends are also cut out, and the windings are accommodated in the continuous channel so formed. It is wound with what are termed the primary and secondary windings, which consist of a few turns of a comparatively thick wire for the primary winding, and a large number of turns of a very fine wire for the secondary. The commencing end of the primary wire is in metallic contact with the armature core, that is, soldered, and the commencing end of the secondary wire is soldered to the finishing end of the primary, and at the junction of the two windings a connection is led off to one side of the condenser. The finishing end of the secondary is attached to the slip-ring, from whence the high-tension current is drawn off via the carbon-brush, and in the case

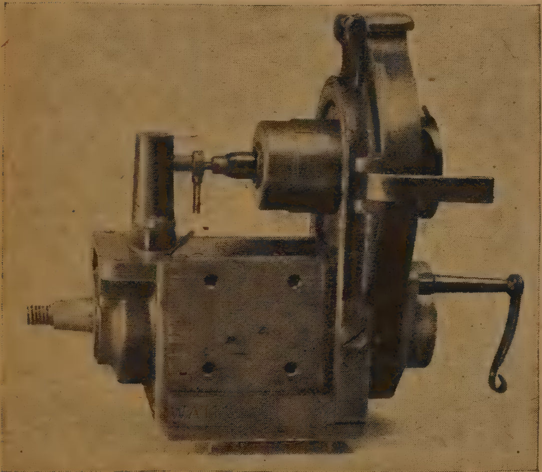


Fig. 2.—View of High-tension Magneto of Rotating-armature Type, the Magnet being removed to show safety spark-gap

of a magneto firing four cylinders or more, thence to the distributor.

The condenser is usually contained in a drum-like brass case at one end of the armature, although in some instances it is separately contained in a casing lying in the space over the armature tunnel.

Fig. 3.—Another View of the same Magneto as in Fig. 2, the Covers and Cam-ring having been removed

It consists of a large number of tinfoil sheets, each of which is insulated from its neighbour by a thin sheet of mica. Alternate sheets of tinfoil are connected together, therefore there are two bunches of tinfoil, which are insulated from each other, though the leaves are alternately superimposed.

The contact-breaker as such is known to all, and will be dealt with in detail later. When there is a distributor attached to a magneto—in the case of the type of magneto now under consideration — sometimes it will be found that there are two exterior connections from the high-tension carbon-brush, one being a steel spring, which presses on a small porcelain cup situated within the arch of the magnets. This is the safety gap, which provides an alternative path for the spark should some of the outer high-tension leads be disconnected, thus avoiding any undue strain upon the insulation of the windings. If the cover of the cup is removed it will

be seen that a small four-pointed brass stud is secured underneath, pointing downwards, and in the bottom of the cup is a similar one pointing upwards. Another type of safety gap is clearly shown in the photograph, Fig. 2. The other connector from the high-tension brush is an insulated lead to the distributor, and it is on this the high-tension current passes via the distributor, en route to the plugs.

Figs. 2 and 3 are two views of a modern high-tension magneto partly dismantled,

Fig. 4.—The Parts of a High-tension Magneto of the Rotating-armature Type

and the parts of the same machine almost completely dismantled are shown in Fig. 4. Fig. 5 (p. 273) is a diagrammatic representation of the windings and connections of a magneto and shows also the relative disposition of the parts. In this last figure all shaded parts are in metallic contact with each other through the carcass of the machine or, as it is termed, "earthed." (Shading has been omitted from the centre portion of the armature core to avoid confusion with the windings.) A is the armature core, P the primary wire, S the secondary wire, C^1 the condenser (insulated side), C the condenser (earth side), E the contact-breaker rocker arm, F the contact-breaker insulated block holding the adjustable platinum-tipped screw, H the distributor, J the junction of the finishing end of the primary winding and the commencing end of the secondary winding, R the slip-ring, B the high-tension carbon-brush, K the diagrammatic representation of the earthed connections, and L the switch.

Magnetos for Engines having more than one Cylinder.—A magneto is capable of producing two sparks per revolution of the armature; but a spark is only produced at the instant the contact-breaker points separate. Therefore if it is arranged that the points break once each revolution, there is a single-cylinder magneto. Similarly in the two-cylinder magneto, the contact points separate twice in each armature revolution, and in place of the continuous slip-ring of the single magneto there is a segment of metal, mounted in an ebonite ring, which makes contact alternately with two diametrically opposed carbon-brushes, therefore no distributor is necessary. Both the single-cylinder and the double-cylinder magneto are driven at half engine-crankshaft speed. In the case of the four-cylinder magneto, four sparks are required per two revolutions of the engine crankshaft, therefore it is necessary to double the speed of the armature, which is one revolution of armature to one revolution of engine crankshaft. The same principle holds good for higher numbers of cylinders, and in the case of the six-cylinder the ratio is three revolutions of armature to two of the engine crankshaft. Eight cylinders would be two revolutions of armature to one of engine crankshaft. With higher numbers it is

usual to duplicate the magneto in order to avoid excessive armature speeds. Obviously a distributor is required for all magnetos firing more than two cylinders.

Looking for Faults.—Before jumping to the conclusion that the magneto is at fault, look well for possible outside sources of failure to obtain a spark at the plugs. Further, if the magneto is removed, do not immediately dismantle it, but proceed step by step until the trouble is found. When removing the magneto from the engine the coupling should be marked so as to ensure replacing it in the same position, and whilst it is uncoupled the engine crankshaft should not be turned, otherwise it will necessitate re-timing.

It will now be assumed that some part of the magneto is faulty and not functioning properly, and endeavour will be made to trace the trouble. In the first place, undo the connection to the distributor, and turn the connection to the safety gap away from the porcelain cap, so that the end is not in contact with anything. The distributor connection can be removed by taking off the distributor cover, when it will be found that the insulated rod can be pushed through, it merely being a spring fit on the top of the high-tension carbon-brush holder. If one end of a piece of stout wire is now twisted round the brush-holder top, or in the case of a machine similar to that shown by Fig. 2, round the top part of the safety gap, and the other end brought within $\frac{1}{32}$ in. of the magnets, or other exterior part of the machine, and the armature turned smartly round by hand, it will at once be possible to determine if the fault is in the distributor or safety gap, for if a spark passes, the trouble is exterior to the high-tension brush. (In the case of the single-cylinder or two-cylinder magneto the safety gap is in the interior of the machine, so is not concerned at present.)

Supposing that a spark does occur. The space at the end of the wire should be opened a little and repeated trials made up to $\frac{1}{4}$ in., in order to ensure that the spark is sufficiently strong, it being easier for a spark to pass in air at atmospheric pressure than in the higher pressures which obtain in the engine cylinders. If the spark is considered satisfactory, attention should now be given to: (1) the distributor insulated connector; (2) the distributor cover; (3) the distributor carbon-brush and brush and brush-holder; (4) the relative positions of the distributor segments and distributor carbon-brush, when the contact-breaker points are just about to separate (unless the magneto has previously been interfered with this does not need consideration); (5) the safety-gap cup and cover. Examining these in the order named, see that the connection, when fitted, makes proper connection with the brush-holder and the centre of the distributor cover, and that the spring-plunger, which is at one end, is free. The distributor cover should be examined for cracks, which when filled with dirt might allow of leakage. The distributor carbon-brush may have worn on one side, in which case it may need renewal, or, if not badly worn, trimming up with a file. Observe that, when fitted, the brush is pressed into contact with the distributor cover. The large gear-wheel to which the carbon-brush is attached should be so meshed that at the moment of the contact-breaker points separating, the carbon-brush is fairly on one of the segments on the inner side of the distributor cover. In some cases, to re-mesh this wheel it is necessary to remove the field-magnets, and in doing this the following points should be noted.

Removing and Refitting the Field-magnets.—Before removal the magnets should be marked, so that they may be replaced in exactly the same positions. Each magnet has a north and south pole (the poles, so called, being the end of each limb). Now apart from the matter of getting the screw holes to register correctly when replacing, all north poles must be at one side of the magneto, and all south poles at the other. It is immaterial which side either particular pole is placed, provided that all are alike on the one side. If the magnets are compound, this rule applies just the same as regards the upper and under magnets. Should the magnets by any chance have got mixed up, and the poles be not marked, it is a simple

matter to determine which poles are alike. One of the laws of magnetism is that unlike poles attract and like poles repel. Therefore, if two magnets are brought together and the attraction is strong, it can be taken for granted that a north pole is on a south. Determination can also be readily accomplished with a compass needle, the north pole of which will turn away from the north pole of the magnet.

Another point in connection with the removal and refitting of the magnets is to take care that the screws holding them are replaced in the same series of holes, for these are of different lengths, and entering as they do the sides of the armature tunnel where the metal varies in thickness, it is possible for them to foul the armature and perhaps cause damage.

When the magnets are removed, a piece of soft iron should be laid across each, from pole to pole; they should also be preserved from knocks, as any sudden jarring tends to weaken them. Reference will be made to the strength of the magnets later, and reversion now made to the meshing of the gear-wheels.

On the rim of the gear-wheel to which the rotor (ebonite brush-holder) is fixed will be found two letters, L and R, with a centre punch mark on a tooth opposite each of them. Now find the direction of rotation of the magneto, which is denoted by an arrow stamped on the top of the end cover at the drive end. If it is a left-hand magneto and having the arrow pointing to the left when viewed from the drive end concern is only with the letter L; or if the arrow points to the right with the letter R. Then turn the armature round until the marked tooth, near the letter which denotes the direction of rotation of the magneto being dealt with, is in mesh with the pinion on the armature shaft. See if there is a mark between the teeth into which the marked tooth meshes, if not, mark it lightly with a centre punch. With the magnets removed, it will readily be seen how the large gear-wheel can be withdrawn. Upon the gear-wheel, in some cases, will be found an incomplete aluminium circle, which is for the purpose of silencing any ringing of the wheel.

In the preliminary test of the spark, it was assumed that a spark was obtained at the high-tension terminal. It will now be assumed that such was not the case. or that the spark was very poor. The carbon-brush or brushes should be the first details to be examined. See whether these are much worn and require renewing, and also test the springs and ensure that the brushes slide freely in their holders. Sometimes a carbon-brush breaks off and a portion remains inside the casing; therefore hold the magneto upside down and shake it. The slip-ring should be carefully wiped with a piece of rag moistened with petrol.

Trouble in the Contact-breaker.—The contact-breaker is the next part to be investigated. Turn the armature slowly round and carefully examine the opening and closing of the platinum points. They should open for a distance not exceeding 0·015 in., and close firmly and squarely. The surfaces of contact should be bright; also it should be observed that when together there is an actual pressure. In dealing with the contact-breaker the primary or low-tension circuit is being treated, and in this circuit it is of vital importance that all electrical contacts, screws and joints should have good metallic contact, or, where possible, be soldered. The object of a small opening of the contact points is that if the distance is large, too great an interval of time elapses during their closure, and the armature has rotated a considerable distance before they come into contact.

There is a very prevalent fault concerning the actuation of the contact-breaker. Perhaps a magneto has been in a more or less damp atmosphere, and the moisture has caused the fibre bush on which the rocker arm is pivoted to swell, and also possibly rusted the pivot, the result being that the rocker arm does not work at all, but remains stuck open, or that it works sluggishly; and whilst perhaps functioning at slow speeds, will not work rapidly enough for high speeds.

The remedy is obvious. Remove the spring and then the rocker arm, when the pivot can be polished with emery-cloth, and, if necessary, the fibre bush reamered out slightly. In this connection also observe that the spring is sufficiently strong to actuate the rocker arm in the proper manner.

The next matter for consideration whilst the contact-breaker is in situ, is the state of the fibre block at the end of the rocker arm, and the state of the segments which actuate the rocker arm. If either is worn, it should be replaced. The fibre block is usually a pressed fit into the end of the arm. If the fibre block is much worn, there is a possibility of one branch of the rocker arm coming into contact with the insulated centre-piece; also the platinum points are prevented from meeting squarely. If it is observed, in the case of a magneto in which the contact points separate twice per revolution, the amount of separation is not equidistant, it will be found probably that the contact-breaker body is not mounted correctly on the armature spindle, or that the irregularity is caused by looseness or wear of the segments, or else perhaps some fault in the position of the annular casing carrying the segments.

The contact-breaker main-plate has a taper boss at the back which fits into a taper hole in the armature spindle; a screw in the centre of the contact-breaker holds it in position.

To remove the contact-breaker, take out the screw, and then give a light tap on the face of the contact-breaker towards one side, when it will become loose. A small carbon-brush will be found at the back of the contact-breaker plate. This is for the purpose of ensuring that the contact-breaker main-plate is constantly in good electrical connection with the body of the magneto.

It will be noticed that in the taper hole of the armature shaft a small key way is cut, and that on the taper boss a key is either fitted or the metal is pressed out to form a key. Detailed mention must be made of this. There is a certain position of the armature, relative to the field-magnet pole-pieces, at which the contact points must separate, and it will be readily understood that a very minute error on the small circumference of the boss produces a very large error in the very much greater circumference of the path of the end of the rocker arm, and therefore considerable error in the timing of the operation of the contact-breaker. This will be clearly understood on reference to Fig. 6.

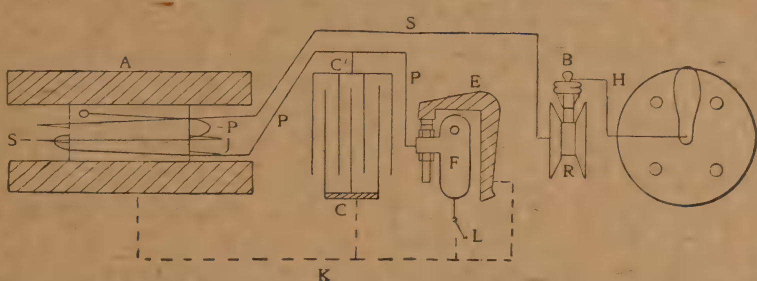


Fig. 5.—Diagrammatic Representation of High-tension Magneto. *(For references see p. 270)*

The central block holding the contact screw is insulated from the body of the contact-breaker, and it will be observed that the screw which holds the contact-breaker in position is also insulated from the contact-breaker body, and serves as a means of connection from the primary winding at the finishing end, and therefore also one side of the condenser to the contact screw. The other contact point is in metallic connection with the body of the machine, or, as it is termed, earthed. The insulation of the contact-screw block, and also

the insulating bush for the central holding screw, should be examined, and if found defective should be renewed. Ebonite is the insulating material used, which, with a little care, can easily be filed and drilled.

Broken or Badly fitting Contact-breaker Key.—Sometimes it happens

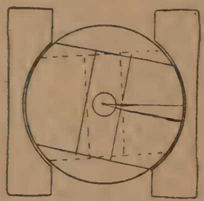


Fig. 6.—Diagram showing Result of Small Error in position of Contact-breaker on Armature Shaft of Magneto

that the key on the contact-breaker boss shears off, and allows the contact-breaker to turn out of its correct position; or that the fit is of an indifferent nature, allowing a certain amount of play, the boss having merely been kept in place by the friction fit of the tapers when eventually it has moved slightly. In this latter case, if the movement was only slight, probably the magneto would give a spark, but of a very weak nature. The correct position can best be determined by experiment; but it will be found that usually when one side of the armature is just leaving a pole-piece, the contact points should just begin to separate; slight variations, however, occur in different machines. The approximately correct position is shown by Fig. 7 herewith.

Perhaps the simplest method of effecting a repair to the key is to file off the old key carefully, and solder a small strip of brass in position. If at first the correct position is not obtained, it is easy to re-heat and move the key slightly. Care should be taken that the shape of the boss is not altered, otherwise it will not fit securely in the taper hole, and the contact-breaker will have a tendency to wobble. Also, heat should not be applied to the contact-breaker until all the insulating material is removed.

Condenser Failure.—If when turning the armature smartly round violent sparking is observed at the contact-breaker points, some failure of the condenser may be suspected, either by perforation of the insulating mica sheets or a broken connection. The condenser is usually situated within a brass drum, which is attached to one end of the armature. Before removal the brass drum should be marked to ensure replacement in the same position, and note should be made of the connections, though reference will be made to these when the armature windings are under consideration. Should it be found that the condenser insulation is at fault, and not merely a broken connection, it will be necessary to replace the whole lot, for the perforation will probably be too minute for detection. Careful dissection of the condenser will show its construction, and bearing in mind one or two important features, its reconstruction does not present much difficulty. The sheets must be of the same size as the original ones, and also the mica of the same thickness, for apart from the question of space, its dielectric capacity varies with its thickness. It is important that the condenser as a whole should be very firmly pressed together.

Armature Re-winding.—Re-winding an armature calls for the exercise of a vast

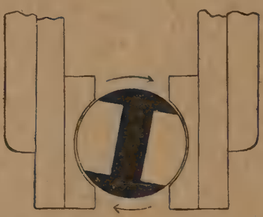


Fig. 7.—Position of Magneto Armature when Contact Points Should Begin to Open

amount of care and considerable patience, rather than a high degree of skill. The primary wire presents no difficulty, but the secondary wire is as fine as a hair, and it is necessary that it should be wound evenly and be free from kinks and breaks. Therefore it will be understood that the winding of the secondary is no light task.

Some arrangement will have to be provided to allow of the armature being pivoted between its two cheeks; the ingenuity and resources of the reader will decide the simplest means available. It is not advised that it should be gear-driven, for unless a very elaborate appliance was used the winding would be irregular.

If the armature is soaked for several hours in methylated spirit, the removal of the old wire will be facilitated; and further, if it is removed carefully and methodically, a good deal will be learnt of the method of winding. No definite data can be given as to the quantity or thickness of the primary or secondary wires, for these factors vary with each type and make of magneto; but an approximate idea of quantity can be determined by weighing the old wire; the sizes can be measured; usually the gauge of the primary is No. 22, and that of the secondary No. 40 or 42. It is essential that the wire be quite new and free from kinks. There will be required in addition to the wire, some insulating silk or special tissue and insulating varnish. This latter is a very high-grade special varnish and should be obtained from some good firm of electrical dealers. Most of the modern magneto windings are of enamel-covered wire, as this gives a better space factor, but it is difficult to handle without damage and an amateur would be better advised to use double silk throughout. Cleanliness and good quality materials are absolutely essential; a particle of metal in the windings could easily prove fatal to success.

All the old insulating tissue should be removed from the armature core and new tissue put on, using the varnish with which to stick it. When dry, the primary wire can be attached to the core by soldering, and the winding commenced. The direction of winding is immaterial, but the convolutions must run evenly and lie snugly side by side. On no account must a convolution of an upper layer be allowed to sink into a lower layer; particularly is this the case with the secondary wire. It must be borne in mind that with each turn of wire the potential increases when the machine is working, therefore though there is little likelihood of leakage between two successive convolutions, there is a very great possibility as the winding proceeds. This also applies to insulation of the wire from the armature core, for although one end of the secondary is earthed through the primary to the core, at the other end the full potential exists. Consequently there is a strong tendency for a spark to pass from any coil of wire in the region of the finishing end to the core.

When the primary wire has been put on it must be carefully covered with a layer of insulating tissue and varnished. It is understood, of course, that before winding is proceeded with the varnish must be quite dry. The secondary wire is attached to the finishing end of the primary by soldering (spirits of salt must not on any account be used as a soldering flux, but resin only). A wire is led from the junction of the primary and secondary for attachment later to the insulated brass piece, into which the contact-breaker holding-screw fits, this being also in connection with one side of the condenser. It is impossible to devote too much care to the winding of the secondary. Successive layers must be most carefully insulated, yet too much space must not be occupied with insulation, otherwise it will be impossible to get the full amount of wire on. Not only must the insulation be good, but as the winding has to withstand centrifugal force when the armature is revolving, it must be mechanically strong. Note should have been taken of the method of securing the windings, and allowance made when commencing winding. In some cases the winding is secured by a binding within the cheeks of the core, and in other cases the core is grooved externally, which allows of bindings completely round the core and windings.

When the secondary winding is completed, a short length of a thicker wire should be soldered on for attachment to the high-tension slip-ring. Finally, over all a binding of insulation should be put

Fig. 8.—Magneto Armature showing Method of Insulating Joint in Secondary Wire by means of Silk Flap

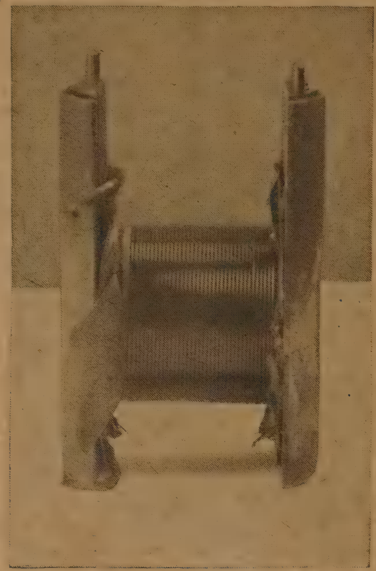


Fig. 9.—Magneto Armature showing Outer Layer of Primary

Fig. 10.—Magneto Armature showing Method of Finishing Secondary Winding

Fig. 11.—Magneto Armature showing Decrease in width of Outer Layers of Secondary Winding

on, and then several coats of varnish applied, each coat being allowed to dry thoroughly before applying another. All soldered joints should be left smooth and carefully insulated. Should the wire break in winding, it may be carefully soldered and insulated; but joints cause unevenness of winding, and are likely to prove detrimental.

Some idea of the windings of an armature will be obtained by a study of the photographs Figs. 8 to 11. It will be observed that the secondary layers diminish in width as the winding proceeds in order that they do not too closely approach the iron cheeks towards the finish.

Before refitting the armature it should be left in a warm, dry place for several days in order thoroughly to dry it.

The Electrical Connections.—A summary of the electrical connections is as follows: The commencing end of the primary is earthed to the armature core; the commencing end of the secondary is joined to the finishing end of the primary; a wire is led from this junction to an insulated piece of brass, which receives the screw holding the contact-breaker in position. This screw, however, is only in electrical contact with the insulated block which is mounted on the face of the contact-breaker, and which block carries the adjustable platinum-tipped contact screw. The other platinum contact is, of course, mounted on the rocker arm, and so is in electrical contact with the body of the magnets, or, as it is termed, earthed.

The wire from the junction of the primary and the secondary is also in connection with one side of the condenser; the other side of the condenser is earthed. The finishing end of the high-tension wire is led to the high-tension slip-ring, and thence via the high-tension brush to the distributor.

Remagnetising the Field-magnets.—No detailed mention has been made in this chapter of the strength of the field-magnets. With fair use the magnets should remain sufficiently strong for a period of five to ten years. Vibration and heat are very detrimental, and the permanency is very dependent also on the hardness and class of steel. They can be remagnetised by placing them on the poles of a powerful electro-magnet, the current of which should be switched off for a few seconds at intervals. The north pole of the magnet should be placed on the south pole of the electro-magnet. They can also be remagnetised by passing a current of electricity round a coil of wire placed on each limb; it is essential that the current should pass round the poles in a certain direction. With the limbs of the magnet towards the observer, the current from the positive terminal of the source of electricity should pass round the south pole in a clockwise direction, and round the north pole in an anti-clockwise direction.

Unless a quantity of magnets is being dealt with, it would be cheaper and quicker to have the remagnetising done by an electrical firm.

General Hints on Overhauling.—A few general hints will be given at the risk of repetition. Use a good screwdriver of a suitable size for the screw requiring removal, for many of the screws will be found to be tight, and if damaged by a badly fitting screwdriver cannot be screwed up tight again. Do not dismantle more of the magneto than necessary. For instance, if it is only necessary to remove one end-plate, do not disturb the other; for as the clearance between the armature and pole-pieces is so very small, it is sometimes very difficult to get the exact alignment if both bearings are disturbed. All parts before dismantling should be marked, and it is even advisable to replace screws in the original holes. Repairs of condenser and windings should only be attempted as a last resource, or if it is known definitely that they are damaged.

The base-plate of some magnetos is rather thin, and when such a magneto is mounted on an iron bed there is a considerable loss of efficiency owing to the iron providing a partial path for the magnetic lines of force. A brass or aluminium bed will be found to be much better.

Water or Oil in the Magneto.—Should water or oil get into the magneto, the machine should be dismantled only to an extent to allow of cleaning. Water would probably interfere chiefly with the high-tension system, and probably a slow and careful drying will put matters right ; but, failing that, the machine should be dismantled and carefully cleaned. Oil, on the other hand, would most likely cause a failure in the low-tension system, particularly the contact-breaker. Neither water nor oil is likely to produce any permanently serious defect.

Chemical Weather-glasses

CHEMICAL weather-glasses, known also as storm glasses and camphor barometers, do not accurately foretell the weather, but they are very interesting, owing to the changes which take place in the solution contained in the glass tube. Such changes, however, are mainly due to temperature, but temperature and weather generally change together. In spite of their alleged unreliability, chemical weather-glasses have withstood the test of time, as they have been in use in one way or another for nearly 200 years. Their present-day form is that of a glass tube filled with a more or less cloudy solution, the tube being fixed to a wooden holder—thermometer-style. Sometimes a thermometer is on the holder with the chemical glass.

The glass tube should be about 10 in. long and $\frac{3}{4}$ in. in diameter, filled to within 1 in. of the top with the necessary solution and then sealed. The formula for the solution is : Camphor, 2 dr. ; potassium nitrate (saltpetre), $\frac{1}{2}$ dr. ; ammonium chloride (sal-ammoniac), $\frac{1}{2}$ dr. ; absolute alcohol, 2 oz. ; distilled water, 2 oz.

This formula is considered to be the best one, but some people prefer the following :—Camphor, $2\frac{1}{2}$ dr. ; potassium nitrate, 38 gr. ; ammonium chloride, 38 gr. ; absolute alcohol, 6 dr. ; distilled water, 9 dr.

Whichever solution is used, it should be shaken and subjected to very gentle heat in order to dissolve the solids thoroughly, and placed in the glass tube while still warm. It is better to use the purer form of ammonium chloride rather than the commoner form known as sal-ammoniac, but the latter will serve if fairly good and quite clean.

A beautiful fern-like and feathery crystallisation develops at the top, and sometimes throughout the liquid during cold and stormy weather. As the cloudiness or crystallisation grows downwards, the longer the cold weather is likely to continue.

In fine and warm weather the opposite is the case, the crystals disappearing, and the liquid becoming clear. Therefore, the greater the proportion of clear liquid in the tube the greater the probability of fine weather and dryness of atmosphere.

When the upper part of the solution is clear, and crystallised flakes form in the body of the liquid, and rise to the top and aggregate, windy and stormy weather may be expected.

If the weather happens to be cold and fine, and the upper part of the liquid becomes cloudy and thick, a spell of wet weather is indicated.

In fine summer weather the coming of rain is forecasted by small clear crystals rising to the surface, the liquid remaining clear with no sign of cloudiness.

A clearly defined fern-like formation of the crystals, with very sharp points, is a sign of very fine weather, but when they break up and lose their sharpness, unsettled weather may be anticipated with some confidence.

Scraping and Glass-papering Woodwork

High-class woodwork is finished by planing, scraping and glasspapering. Planing having already been dealt with, the two other processes remain to be explained in this chapter. At least two shapes of woodworker's scraper will be found useful, the regular oblong shape, as bought from the tool shop, and one made from the broken-off end of an old saw-blade, its corners being rounded for scraping the hollow parts of mouldings, etc. (see Fig. 1).

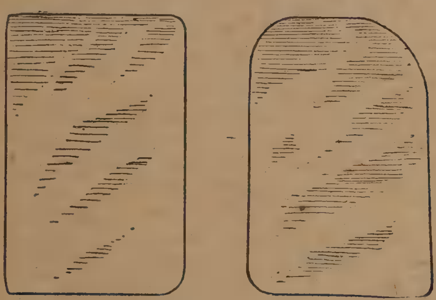


Fig 1.—Two Patterns of Woodworker's Scraper

Sharpening the Scraper.—It should be said that success in using a scraper depends on its proper sharpening. A new scraper requires the straight edges to be filed to a slight curve, and when in use it also requires filing occasionally and setting frequently.

Fig. 2 shows the curved edge being filed square with a flat, round-edge circular-saw file (which, of course, is not the only file that could be used for the purpose). It is next ground smooth on the oilstone, as in Fig. 3, care being taken to keep it quite square. Paraffin oil is a good lubricant to use. Sometimes it is convenient to use the side of the oilstone, as in Fig. 4.

Fig. 2.—Filing Scraper Edge Square

When the edge is quite smooth and square it is ready for setting. Both edges of each scraper should be set, also the round corners, as shown by Fig. 5. For setting the edges, any suitable hard-

steel tool may be used; the back of an old razor blade set rigid in a wood handle makes an excellent tool for the purpose, is laid flat on the firm end of the bench, the chisel being laid upon it in the position shown by Fig. 6, then, with a good

Fig. 3.—Squaring Scraper Edge on Oilstone

Fig. 4.—Squaring Edge on Side of Oilstone

Fig. 5.—Squaring the Corners

Fig. 6.—Burring the Scraper

or a punch, or the back of a gouge. The writer employs an old bevel-edge chisel, the steel of which has been found by experience to be too hard to take a fine edge without snipping. The scraper even pressure, the chisel is pushed forward to the other corner. This is repeated seven or eight times, and each side of each edge is treated the same.

The next process is to turn the edges

by stroking along them several times with considerable force, in the manner shown by Fig. 7, keeping the chisel at right angles with the scraper. Another way of doing this is shown by Fig. 8. Finally, the chisel is held slant, and also at an angle of about 65° with the scraper; then, with firm, even, but only moderate pressure, it is drawn along the edge (this time towards the body) about twice only, as shown in Fig. 9.

Each scraper has four cutting edges, all parallel with one another, and they can be felt and seen. The manner of using the scraper is shown by Figs. 10 and 11. It takes off soft, fine, curly shavings with moderate ease, but its use is largely a matter of skill on the part of the workman, both in sharpening it and applying it to the work.

Fig. 7.—Turning the Scraper Edge

It is doubtful whether there is better material for making a scraper than a piece of a saw-blade; but an old, rusty piece is not suitable. Should a saw-blade break, the cause may be excessive hardness, a quality that well fits it for use as a scraper; it should, however, be sufficiently elastic to "give" slightly in working, and to allow of the burr edge standing without stripping. Should stripping occur, the whole process of sharpening the scraper must be repeated. It should be remembered that the scraper is miscalled; its function is to cut, not to scrape, but the latter is all that a badly sharpened tool can effect. The cutting action is well indicated in the diagram (Fig. 12), which correctly illustrates the

Fig. 8.—Another Position for Turning the Edge

Fig. 9.—Finishing the Scraper Edge

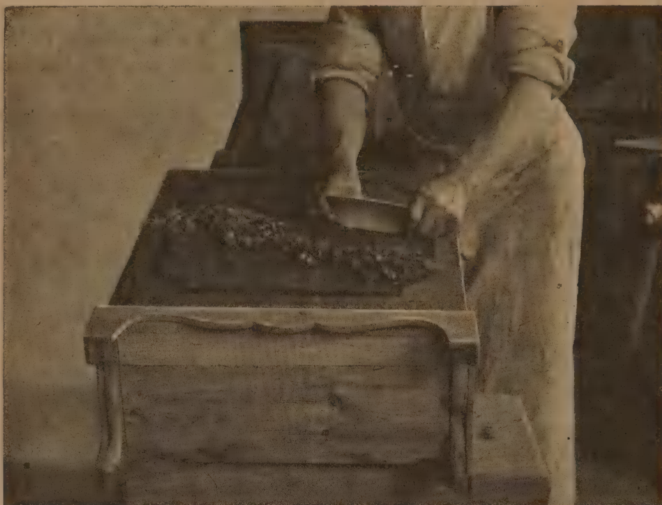


Fig. 10.—Using the Scraper

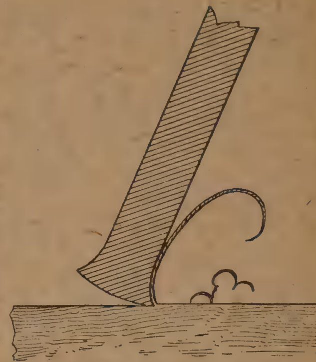


Fig. 12.—Diagram Illustrating Why the Scraper Cuts

cutting principle, while not representing a true section through a scraper. Properly sharpened and used, it should remove from the work, at each stroke, a fine, even shaving, nearly as wide as the scraper, and should give what the workman calls a "sweet" action, the absence of which is evidence that the sharpening has been improperly done or that the surface of the work has not been suitably prepared. The scraper corrects, not makes, surfaces. The scraper is held in the two hands, as illustrated in Figs. 10 and 11, inclined with gentle pressure until its edge gets a "tooth" in the work, and then pushed from the worker; only occasionally is the scraper used by drawing it towards the worker.

It should be made clear that the scraper is not a substitute for the smoothing plane; properly, it should be used only on surfaces that have already been planed smooth and level. The scraper removes the marks and ridges left by the plane, and its use is followed by that of glasspaper. Occasionally the scraper is used as almost the sole means of dressing up cross-grained surfaces occurring in woods having a decidedly curly grain.

GLASSPAPERING WOODWORK

The use of glasspaper is essential on all woodwork that is finished by varnishing, painting, or staining, and in many cases

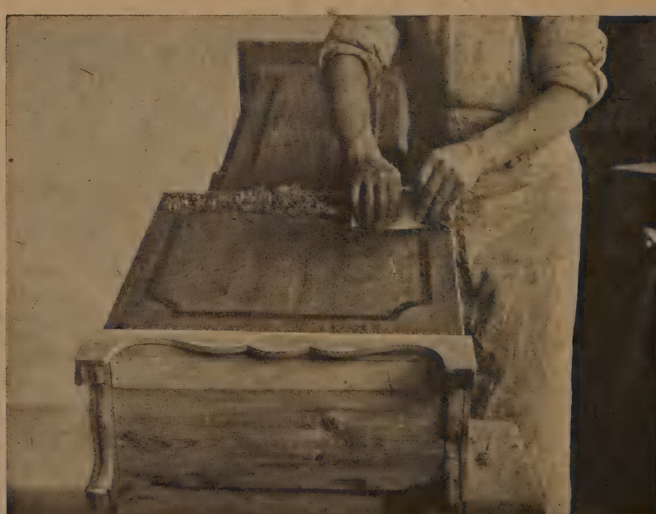


Fig. 11.—Using the Scraper

it is necessary for removing tool marks where the bare wood is afterwards left untreated by any of these processes. An exception occurs in rough carpenter's work, which is never glasspapered, although such work sometimes receives one or more coats of paint.

It would scarcely be supposed that friction from the rough surface of a piece of glasspaper could have a smoothing effect on the surface of a piece of wood which is already smoother than the glasspaper. But the sharp points of glass or flint on the paper are so numerous that they have a scraping and levelling action on the wood, which is rough because of the inequalities on its surface. These inequalities are caused in the first place by the cutting tools, which leave marks of their own. A narrow strip of wood can be planed without any tool marks showing; but a surface wider than the plane shows waves caused by the necessary curve in the edge of the plane iron. In the use of chisels and gouges the tool marks are still more apparent, and in either case glasspaper must be used to produce either uniform flatness or uniform curvature of surface, as the case may be. It does this without making the wood actually any smoother; in fact, the contrary is rather the case, because bare wood cannot be glasspapered as smooth as a sharp tool will cut it, the only use of glasspaper at this stage being to remove ridges that the tools cannot remove. Usually this first glasspapering is followed by the application of the varnish or other medium, which protects the wood from dirt and damp and improves its appearance.

Glasspaper is used again after each coat of varnish or paint has dried before applying the succeeding coat; but it is not used after the final coat. Its effect during these stages is decidedly of a smoothing character. The fibres of the wood swell and rise when wetted, and when the surface has thoroughly dried again it feels rough in consequence. The glasspaper entirely removes this roughness, but gives the stained, varnished, or painted surface a slightly scratched and dulled appearance. As more coats are added the roughness on drying becomes less, and to avoid scratching the surface it is best not to rub down the last one with glasspaper.

Figs. 13 and 14.—Flat and Curved Glasspaper Rubbers in Use

As the work proceeds finer glasspaper should be used. For removing tool marks it must be comparatively coarse. For smoothing the surface after two or three coats of varnish have been applied it should be very fine. In the latter case fresh glasspaper is never used, but pieces that have been worn considerably. If these do not happen to be at hand, two pieces may be rubbed face to face, to remove their sharpness and prevent them from scratching the wood too much.

As a rule, glasspaper is used wrapped round what is called a rubber. The

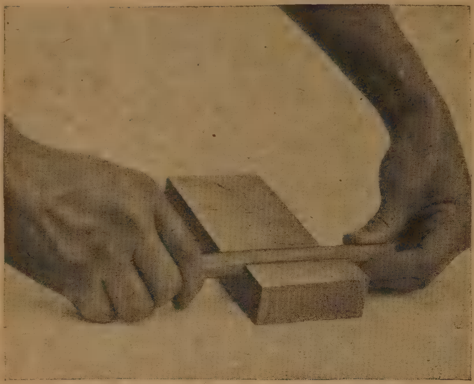


Fig. 15.—Using Cylindrical Rubber

ordinary form of rubber is shown in Fig. 13. It is simply a rectangular block of wood, cork, or any other convenient material, measuring about 5 in. by $2\frac{1}{2}$ in. by $1\frac{1}{4}$ in. The best rubbers are of cork; but wood is more generally used. Its purpose is mainly to keep the glasspaper flat; but it also affords a convenient means of holding and using it. It is used in the same way as a scrubbing-brush, except that it is generally worked only in line with the grain of the wood. If used across the grain, the scratches made by the glasspaper are much more noticeable. When the attainment of a true surface is of more importance than appearance, as in patternmaking, the rubber is worked across the grain at first, but finally with the grain.

Rubbers are not always flat (see Fig. 14),

Fig. 17.—Removing Tool Marks from Rounded Work

but sometimes have to fit concave surfaces. Fig. 15 shows a cylindrical rubber in use. Its movement would be both rotary and longitudinal, as will be clearly understood. It might be the right diameter to fit the concavity, or in some cases the nearest one available of smaller diameter would be used to avoid making one specially. For small holes or semicircles a lead pencil, a piece of dowel rod, or the back of a paring gouge is often suitable for carrying the glasspaper.

In small sizes, diameters can be varied by wrapping more or less glasspaper

Fig. 16.—Removing Tool Marks from Rounded Work

round the rubber. It might be supposed that the use of a rubber in such cases is needless trouble, when a piece of glasspaper could be used in the hand alone; but the latter method would spoil the accuracy of the best work, while the use of a rubber would do something towards making bad work passable.

For concave surfaces of large radius, a block of wood similar to an ordinary rubber may have one of its faces planed approximately to the sweep, as already shown by Fig. 14. For convex surfaces special rubbers are seldom employed. In such cases an ordinary flat rubber may be used as in Figs. 16 and 17, worked

in the direction of the curve, to remove tool marks only. In a case like Fig. 16 it would only travel in the one direction indicated, to avoid returning against the grain. In both examples, after tool marks were removed and varnish applied, the glasspapering would usually be performed without a rubber, as in Figs. 18 and 19, the movement generally following the grain.

For use in narrow places, a thin strip of wood may be used as a rubber ; or a chisel may be suitable. In other cases, a piece of glasspaper folded and held between finger and thumb may be the best way of dealing with work. This method is shown in Fig. 20, where the glasspaper

Fig. 18.—Glasspapering Rounded Work without Rubber

is being used for smoothing out a quirk in a moulding. The curved part of the moulding would also be done with a small piece of glasspaper held in the fingers and pressed to the contour. The movement in both cases would be exclusively longitudinal.

In rubbing down after a coat of varnish it is sufficient for the glasspaper to pass quite lightly two or three times over all parts of the surface. In removing tool marks before varnishing, the pressure should be heavier and the rubbing more prolonged.

How Glasspaper is Made.—Glasspaper consists of strong paper coated with powdered glass. Formerly sharp sand was used, thus the name "sandpaper,"

Fig. 19.—Glasspapering Rounded Work without Rubber

which is still in use. In the manufacture of glasspaper, first the glass is washed and sorted, and then broken very fine by stamps or other machinery.

The different grades of glasspaper are numbered from 3 to 0, and even finer, and there are corresponding sieves to divide the various grades, or to "size," as it is technically called. These sieves are numbered from 140 to 30, the numbers representing the number of meshes per lineal inch ; the finer sieves are covered with Swiss silk, the others with woven wire.

The placing of glass on paper requires considerable skill and experience (we quote from the "Woodworker's Review"). The workman has delivered to him plain papers in reams of 120 sheets, each sheet making four sheets of ordinary size. The appliances used are a copper tank

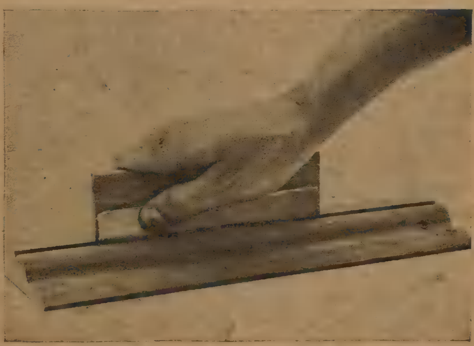


Fig. 20.—Glasspapering Moulding without Rubber

holding 56 lb. of glue, a table, a bench on which the sheets are laid to cover them, a cutting machine, a press for packing glass, and a hot plate for heating the sheets. A special drying-room is another essential.

When all is ready a ream or two of paper is placed on the table, and the top sheet is coated with glue by means of a brush resembling a shoe-brush, but with longer hair. The sheet is lifted by two corners and laid on the bench, glue side uppermost; the bench has a border standing up some 7 in. or 8 in. high on three sides, with a narrow fillet in front. Powdered glass is simply thrown or scraped over the sheet, which then is raised from one side so that the superfluous glass runs off on to the bench and is used again.

The sheet is then placed on the hot plate, a hollow, flat, iron bench heated with steam; this causes the glue to boil up and thus securely fixes the particles of glass on the paper. After drying the sheets are cut to size.

Making a Box Kite

To make the simple form of box kite shown by Figs. 1 and 3, obtain four straight strips of light wood, preferably spruce, 2 ft. 6 in. by $\frac{3}{8}$ in. by $\frac{1}{8}$ in.; these dimensions should be full. Obtain also four other pieces, each 1 ft. $7\frac{1}{2}$ in. long, but $\frac{1}{16}$ in. wider and thicker than the foregoing, and halve their ends to a depth of $\frac{1}{8}$ in. by $\frac{1}{4}$ in., in order that when the false end A (Fig. 2) is tightly bound on, these cross sticks will firmly grip the long pieces edgewise, the sides of the cell being indicated by the dotted lines. The long sticks should be notched at a distance of 4 in. from their ends to receive the forks of the cross sticks.

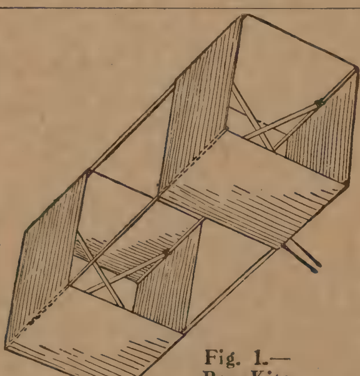


Fig. 1.—Box Kite

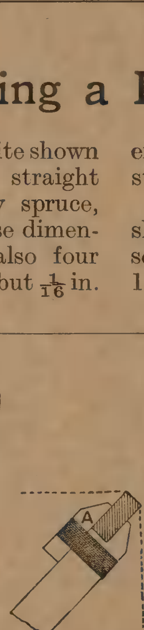


Fig. 2.—False End Bound On

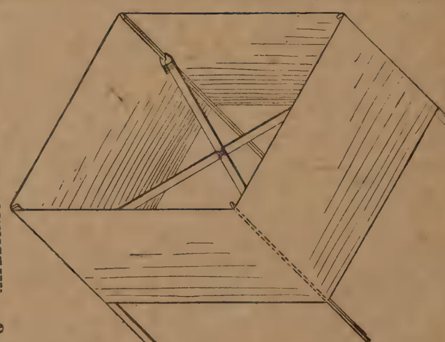


Fig. 3.—End of Box Kite

The width of the cloth or paper cells should be 8 in., and they should be separated by a distance of 1 ft. 1 in. or 1 ft. 2 in., their edges being bound with fine twine. The easiest way to make the cells is to cut two strips of the material, 10 in. wide and 4 ft. $8\frac{1}{2}$ in. long. Turn over the edges $\frac{1}{2}$ in. along each side, and insert fine strong twine. If paper is used, glue the fold; if cloth, stitch the hem. When completed, either glue or stitch the ends of the strip with a $\frac{3}{4}$-in.

lap, so as to form a continuous band. By folding, divide this accurately into four equal parts, and at each of the creases glue one of the long sticks edgewise (see Fig. 2). When dry, the whole can be put together and the flying line attached, without a bridle, as in Fig. 1.

It is advisable in all cases to make the cross-pieces a trifle too long to ensure their straining the band tightly; they may always be shortened by cutting away the shoulder formed by the halving.

These kites are easy to fly. Avoid an enclosed space where the wind whirls in invisible eddies. Having let out 20 yd. or 30 yd. of line, get someone to throw up the kite. If several large kites are sent up in tandem, steel wire is almost essential. Instructions on building model aeroplanes are given in a later volume.

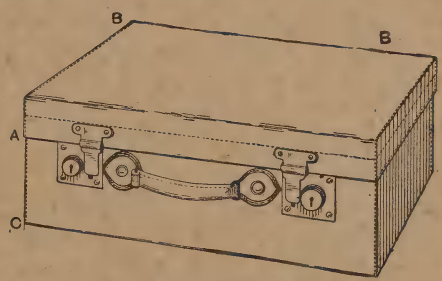
Making a Leather Suit-case

THE leather suit-case shown by the accompanying illustration has a frame of thin iron. The lower frame for the body part goes all round, and measures 22 in. by 16 in. The frame for the lid is from B to B round the front and sides only. This must be $\frac{1}{2}$ in. larger than the inner frame to allow for the thickness of the leather as it passes on that inside. The frame front should be 22 in.. to hold a suit neatly folded with underwear. From A to B is 16 in., and from A to C 10 in. or 12 in.

Begin by cutting some millboard the size of the frame A round to the hinge at the back for the lid part, leaving a piece at each end to fold over the lower half. Cut same to fit the under frame, and the ends must be separate, and stitched coarsely to the body part. These must be drawn to the frame with a thin thread, so as to hold until the leather cover is pasted on. Brown basil leather (sheepskin) or light horse hide can be used. Cowhide is best, but more expensive, and also very heavy, but will last longest. If this is used millboard will not be required. Some use imitation leather, which is the cheapest.

Having decided on the material, damp the under-side well with a thinnish preparation of glue, and draw it tightly down to the frame with long, basting stitches until dry. Do the same with the under-half, and stitch it round the outer edge of the frame, using a thin strip of leather for the under-side. Then stitch the inner rows along the frame, six stitches to the inch; finer stitches would cut the leather too much. Then at the back bring the two together with strong stitches, and on the outside use a strip about $1\frac{1}{2}$ in. wide, with the thin piece inside.

The handle must be the best part of the leather. 1 ft. by $1\frac{7}{8}$ in. of three thicknesses. It is tapered to the edges to make it half round. It is fixed on with brass-headed



A Leather Suit-case

rivets of good size, clinched inside to a piece of leather. The ends can be stitched to make a stronger job. A lock can be riveted in the centre, or one at each end.

The case should be lined with fawn-coloured sateen, using best bulldog paste. Cut the material to fill all round to pass under the margin of the leather that holds the frame, and smooth it neatly with a piece of ivory, such as a knife handle. Dress the edges with glasspaper, and polish with a linen cloth and glue water (weak). Finish with the white of an egg, polishing it all over.

Cleaning and Repairing Dutch, French, Regulator and Lever Drum Clocks

The Dutch Clock. — A familiar form of this old-fashioned clock is illustrated by Fig. 1 on opposite page, the movement, or works, being shown with the parts named. The framework and part of the wheelwork, too, are of wood, and the pivot holes are little pieces of brass tube inserted into holes in the wood. The pivots are steel pins driven into the centres of the wheels, and the pinions are formed on wooden bodies. In some very old Dutch clocks, the wheels themselves, except the escape wheel, are of wood.

To clean one of these clocks, first detach the weight and pendulum; next unscrew the nut that holds on the minute hand, take off the hands, turn the clock over on to its face, and remove the pins that fasten the front of the clock case to the body. Pull them out boldly with a pair of pliers, and then take off the motion work. For removing the train wheels, one of the centre wooden uprights will be found to come out. Take out a pin near the top end, and pull towards the worker, and it will come out. Care must be taken not to bend the pivots.

Clean all the wheelwork as described in the case of the American clock (see p. 26 of this volume), and make a thorough examination as before. The pallets are sure to be cut more or less, and if they will not bear flatting down with the emery stick, recourse must be had to bending the escape wheel backwards or forwards so that the action takes place at another part of the pallets. The wheel, of course, is made to a certain extent cup-shaped by this operation, but that does not much matter.

In these clocks the pallets are often found to have worked loose, and require riveting up again. Beyond that, and the wear of the escapement, there will probably not be much the matter with them. The escape depth can be adjusted by knocking down the bearing of the back pallet pivot. Thoroughly clean the pendulum suspension wires and give them a little oil.

A little fine emery-cloth will improve the appearance of the hands and the brass rim round the glass. As in all clocks, see that it is "in beat" when hung up level. If the pendulum bob is found to be loose, and drops down, tighten by inserting a piece of cork between it and the pendulum-rod.

The French Clock.— One of the better class of pendulum timepieces is the ordinary French movement as found usually in a black marble or wood case, and as illustrated by Figs. 2 and 5 (pp. 291 and 293). Better finish and sounder frame are found in these clocks than is the case with the American or Dutch clock. They are also, as a rule, very good timekeepers, their fairly good wheels and pinions and heavy pendulums enabling them to keep correct to within a minute or two in a week. They go for eight days, and some for fourteen and even twenty-

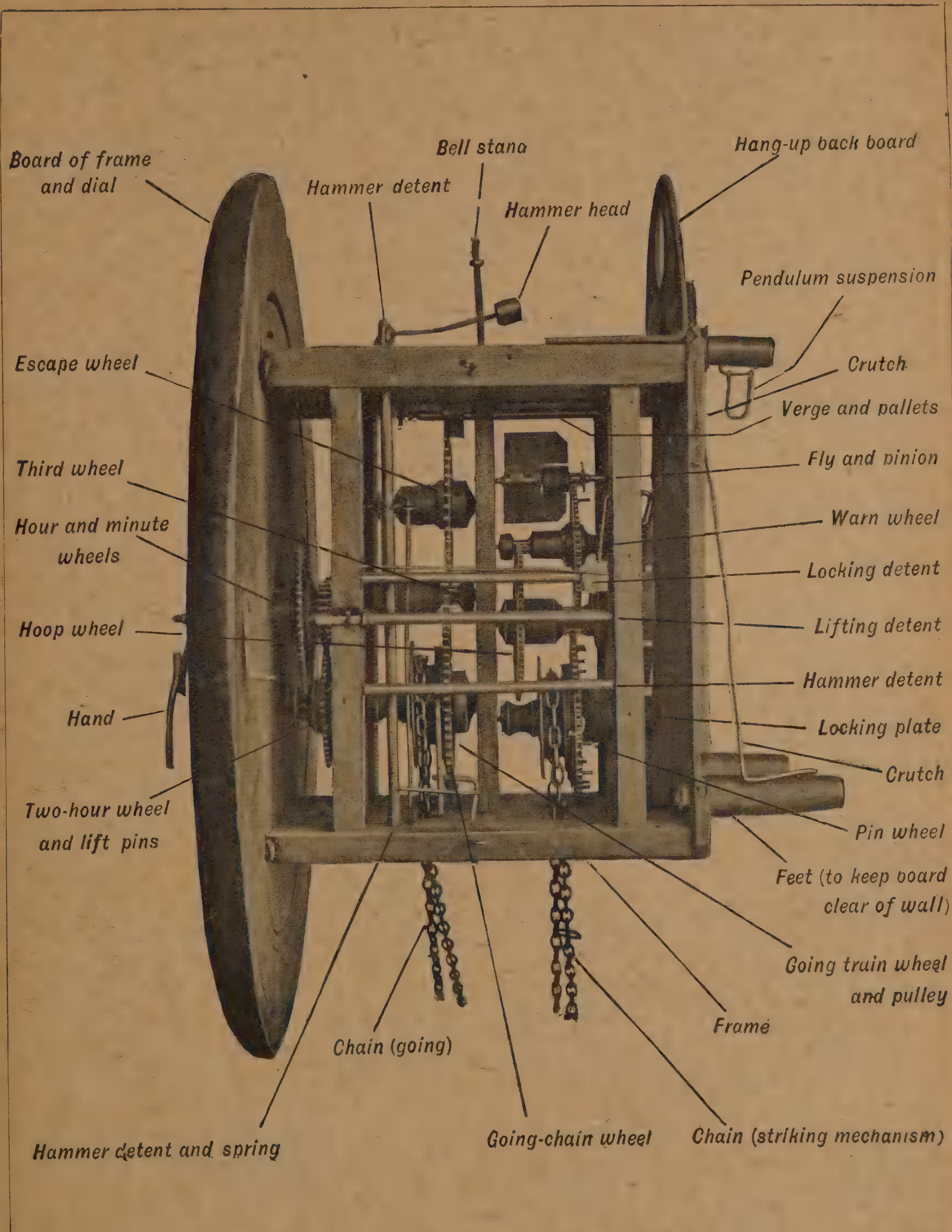


Fig. 1.—Movement of Dutch Clock

eight days, the latter being rather uncommon, though fourteen-day clocks are often met with.

To get the movement out of the case of a French clock, open the back door and remove the two screws, found one on each side, holding the movement to prevent its falling forward. Unhook and take off the pendulum, and then draw the movement out from the front of the case. It will be found to be held in place by two brass arms. Take off the hands by unpinning the minute hand, and the movement can then be unpinned from the frame which holds the dial, etc., and the latter put on one side.

French movements are made in several qualities. The cheapest have rough-filed plates and wheels, and rough and bad motion work (hand work). The motion wheels are placed between the plates, and a set-hand arrangement somewhat similar to that found in an American clock—that is, the centre wheel turns friction-tight upon its pinion. In the better grades quite a different arrangement is found, the centre wheel being fast upon its pinion, and the motion wheels placed between the front plate and the dial, after the manner adopted in a watch. In either case, it must be seen that the hands are not too easy, and the shifting parts must be tightened accordingly.

The winding work—that is, the ratchet and click, etc.—will be found on the outside of the front or back plate, according as the clock winds from the front or back. Before the clock can be taken apart the mainspring must be let down. Place the key on the winding square, and, taking off the pressure from the click, with the finger hold the click up, and allow the key to go back half a turn, letting the click fall back into its place again. Repeat this operation until the spring is completely unwound. The back cock can then be unscrewed and the pallets taken out, the pins can be withdrawn and the plates taken apart, and the clock will then be in pieces.

If all the pivots and wheels are right, and the mainspring not broken, cleaning may be proceeded with. The rough movements referred to above can be cleaned by immersing them in benzoline and then pegging out. The barrel and mainspring, however, must not be put into the benzoline, but wiped clean, and brushed outside with the chalk brush and dry chalk. The arbor and cover can be washed in the benzoline, and cleaned thoroughly before being replaced. Put plenty of oil on the mainspring before putting on the barrel cover, and do not forget to oil the barrel-arbor pivots.

If any difficulty is experienced in getting the barrel cover off, hold the barrel in the hand, cover up, and knock the arbor sharply on the bench or floor, driving off the cover at one blow.

To clean the better class of French movements—those with polished plates—a different method is pursued. Strip the plates—that is, unscrew everything upon them—and mix a little rottenstone powder with sweet-oil to a paste. Put some of this on a rottenstone brush, and vigorously brush the plates and brass wheels, cocks, etc., brushing backwards and forwards straight from top to bottom, to put on an even grain. This done, put all in the hand-bowl, and pour on benzoline, and with the benzoline brush thoroughly wash all rottenstone and grease from the parts. Take them out and dry with a duster, and put on one side for a few minutes for the last traces of the benzoline to dry off. Do not put the barrel in the benzoline, but with the rottenstone brush nearly dry, polish its sides, and clean off with the benzoline brush rather dry, afterwards wiping clean with the duster. All being dry, take the chalk brush and dry chalk, and proceed to brush up and polish all the parts; then peg out all pivot-holes clean, also between the leaves of pinions, and brush through all wheel teeth, to remove any traces of rottenstone.

The clock can next be put together, a little clock oil being applied to pivots and pallets, and just a trace to the crutch where the pendulum hangs.

The pendulum suspension-spring must be treated very carefully or it will easily

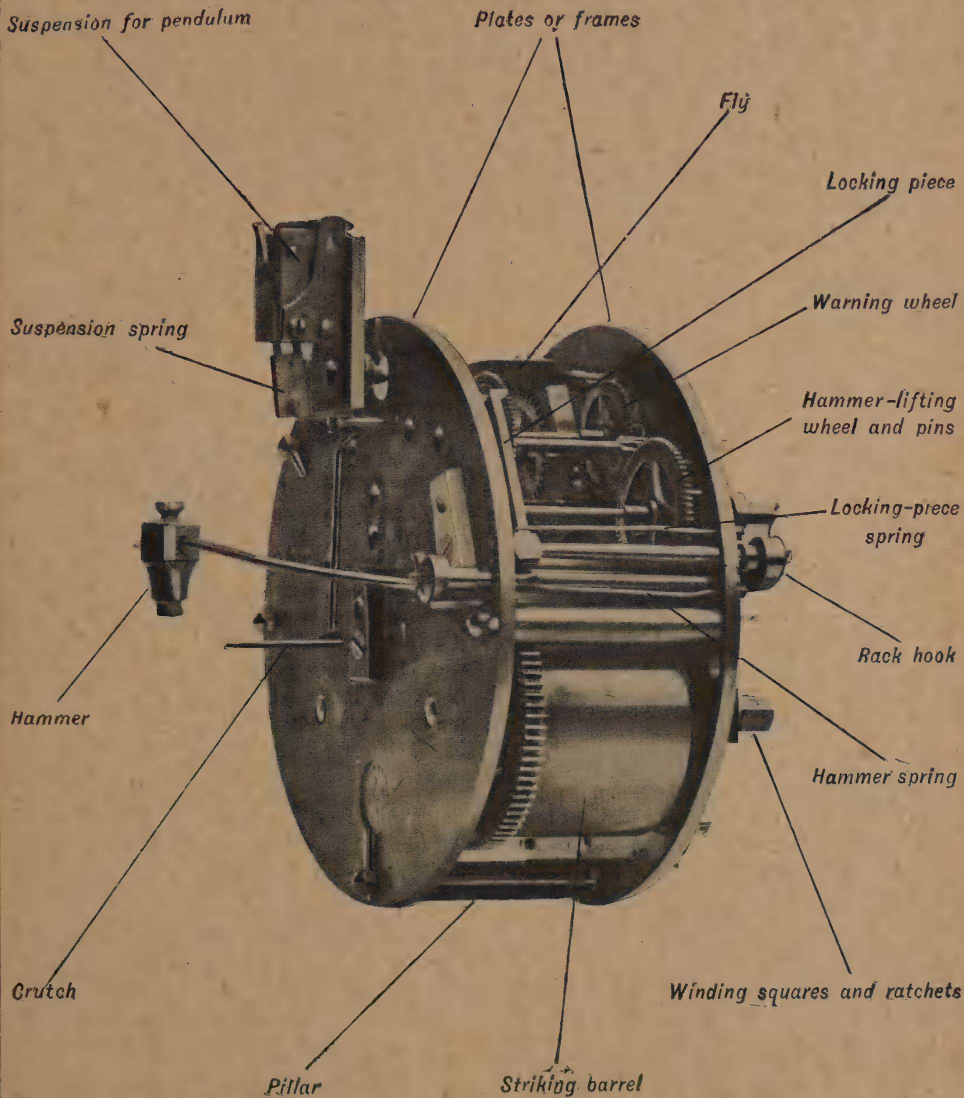


Fig. 2.—Movement of French Clock : Pendulum Side

spoil, and it cannot be again got right. In putting the clock back in its case, see that the 12 o'clock is quite upright, and then set in beat by bending the crutch as usual. These clocks have an excellent regulating arrangement to turn with a small key from the front. Turning to the right shortens the acting part of the pendulum suspension-spring, and so makes the clock go faster, whilst turning to the left has the opposite effect. The entire arrangement is contained in the "back cock," and must be taken apart and carefully cleaned with the rest.

Fig. 3.—French Dead-beat Escapement

French Dead-beat Escapement.—The French steel pallet dead-beat escapement sometimes seen in marble and other clocks is shown by Fig. 3. In repairing it, wear must be buffed out on the impulse faces only, and as in these escapements very few teeth are embraced by the pallets, setting the pallets nearer to the escape wheel will cause it to lock properly. The front pallet pivot hole is in a brass eccentric disc, and can be turned with a screwdriver to adjust the depth of the pallets and escape wheel. When only a few teeth are spanned by the pallets, the pallets are, as it were, on the top of the wheel, and setting them a little nearer makes the teeth lock better. When the pallets span more teeth or a larger part of the wheel, as in English regulators, setting the pallets nearer to the wheel alters the drop, and makes it unequal without making the teeth lock better.

French Recoil Escapement.—Fig. 4 shows the ordinary recoil escapement found in French clocks. It acts in exactly the same way as the English recoil escapement shown in a later chapter, the principal difference between them being that the French escape wheel has more teeth than the English one, and the pallets do not embrace so large a portion of the wheel. The consequence of this is that the angles of the pallet faces are different, and cannot be relied on as an indication of correctness as in the English form. Also, being more "on the top of the wheel," placing the pallets a little closer deepens the action without very much affecting the equality of the drop on each pallet.

To alter the depth, the front pallet pivot is always in an eccentric brass disc with a screwdriver slit across it, by means of which it may be turned round, and the pallets moved a trifle nearer to the wheel. When worn, these pallets become cut into grooves, which should be ground out, with emery buffs, as before described, and, being small, great care must be taken that the corners are not unduly rounded off. After buffing and polishing, the depth will need a little readjustment by means of the eccentric disc just referred to, and if the drop becomes unequal, a trifle taken off one pallet back as described in connection with the English recoil escapement will correct it.

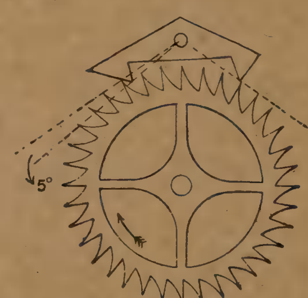


Fig. 4.—French Recoil Escapement

If very badly worn, the pallets of French clocks can easily be shifted on their axis. They fit on a long tapered square, and to get them a little farther along knock them off, reduce the square

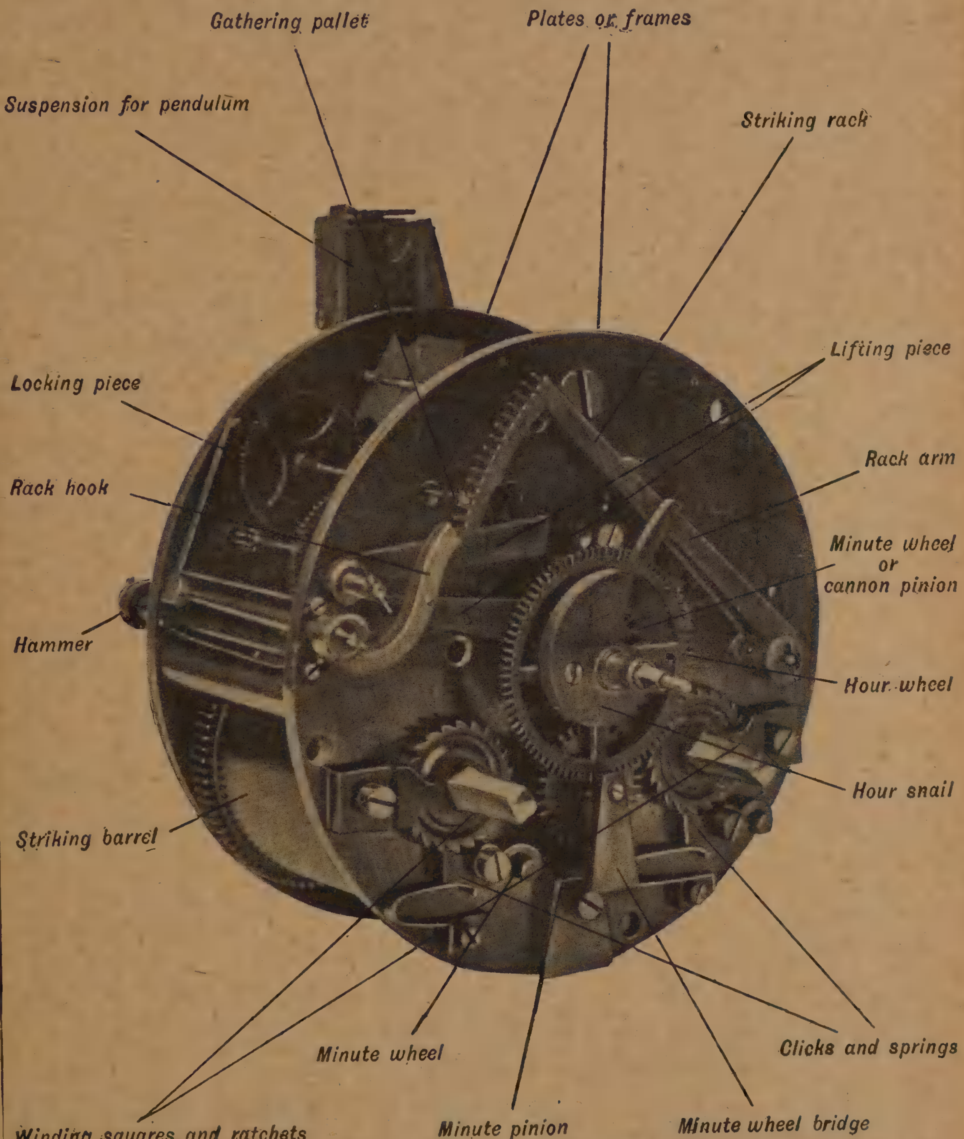


Fig. 5.—Movement of French Clock : Minute-wheel Side

just the least trifle, and knock them on again. Do not attempt to knock them farther along the tapered square without first reducing the square, or, the pallets being as hard as glass they will very likely

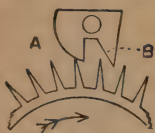


Fig. 6.—Escape Wheel and Pallets of Tic-tac Escapement

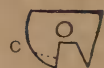


Fig. 7.—Altering Pallet of Tic-tac Escapement

split across the centre hole and be in two parts. In case such an accident happens, the pallets can be reunited by soft soldering, pressing them well together as the solder runs, and washing the acid off well with plenty of water, to prevent rusting. When soldered and washed, the square hole may be cleaned out with a fine file, and the pallets replaced on the arbor. Very little force must be used to drive them on, or the soldered joint will part again, so it is best to let them go on fairly easily, and

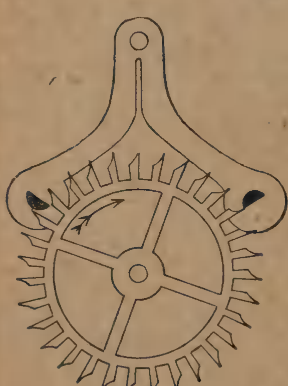


Fig. 8

Fig. 9

Fig. 10

Fig. 11

Figs. 8 to 11.—French Visible Pin-pallet Escapement and Amount of "Drop"

set them by warming a little shellac and making sure it runs well along. The heat necessary to run the shellac will not affect the solder, and it is well to remember that shellac only requires just enough heat to make it liquid. More will only burn it and destroy it, burnt shellac having no holding power.

In case this method of repairing a broken pair of pallets is not deemed good enough for the clock in hand, a new pair may be made, following the directions given for English clock pallets in a later chapter.

Drum Clock Tic-tac Escapement.—This is found in the old French brass drum clocks with little, short pendulums about 3 in. long, fortunately not made now. Fig. 6 shows the escape wheel and pallets. The face A (Fig. 6) is circular, as from the pallet staff, consequently there is no impulse on it, the escape wheel tooth resting "dead" on it, until it drops on B, which is the single impulse pallet. This arrangement wastes power, and consequently the clocks continually stop, especially when they get a little old, as all now are. Some try to alter the pallets as shown at C (Fig. 7) by the dotted line, giving the entrance or "dead" pallet a little impulse, and bringing the pallets nearer to the escape wheel to equalise the drop. But this is not a very satisfactory procedure. A better way is to make a new pair of recoil pallets embracing three more teeth. The clocks then go; but they are poor timekeepers. Some convert these clocks by taking away the pallets and pendulum, and fitting on a platform with a watch-cylinder escapement. But when the cost of this and the labour is counted, also the cost of an extra wheel in the train instead of the old escape wheel, it will be found that a new and better clock can be bought for the money, and the old one discarded or used up as material for repairing.

Pin-pallet Dead-beat Escapements.—The principal of these is the French "visible" escapement often seen in front of the dial in marble clocks of good quality. Fig. 8 shows the escapement. The wheel teeth on the fronts, or acting parts, are straight. Their backs are curved to points to clear the pallets, and have as little drop as possible. The pallet arms are usually of brass, and the pin pallets are round, either driven in tight or cemented in with shellac. When driven

in they are made of steel; when cemented agates are used. The round pins are cut away to half, making them D-shaped, having the curved parts as impulse faces and the straight parts as backs. The

Fig. 12.—Brocot Visible Dead-beat Escapement

straight parts should point exactly to the centre of the escape wheel, and the pins should be a little less in full diameter than the space between two teeth points. The pallets should also be set exactly upright in their holes.

This escapement will be found really simple when its underlying principles are once mastered. The teeth points should fall exactly on the pin centres when they "drop," as in Fig. 9; then as the pallet continues its motion towards the centre of the escape wheel it slides down the straight front of the tooth, and causes no recoil of the wheel or other movement. In impulse, the tooth point slides off the rounded face of the pin, and, leaving its edge, another tooth drops on to the other pallet as in Fig. 9. If the teeth fall as in Fig. 10, they lock too deeply, and the pallet arms must be separated a little more by bending or by warming and shifting the stone back, until the drop is like Fig. 9. If the teeth drop as in Fig. 11, the locking is not deep enough, and the pallet arms must be closed, or the stone moved towards the wheel.

Then there is the amount of the drop. If too much on the entrance pallet, lower the pallets, bringing them closer to the wheel. If too much on the exit pallet, remove the pallets farther from the wheel. If not enough drop on either and the pallets just catch on the teeth points, while the locking is quite correct, probably one pallet back does not point exactly to the escape-wheel centre. In any case, one or both pallets want a slight twist round, so as to let the teeth points drop earlier.

In a visible escapement, generally, the brass escapement cocks are movable a little, and can be strained this way or that as required to adjust the distance between the centres of the escape wheel and pallets. In those in which the pallets are between the plates, the front pivot is carried in an eccentric, like recoil French clocks. But the locking can only be regulated by either closing the brass pallet arms by bending, or by warming the shellac and moving the stones away from or towards the wheel.

If the agate pallets become worn or chipped, they can be warmed to soften the shellac and pushed in more or drawn out, to bring the action on a new part. After this, some considerable adjustment on the lines already described is always needed, as the stones being a slack fit in their holes, it is almost impossible to re-

Fig. 13.—Pin-pallet Escapement

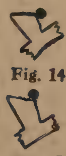


Fig. 14

Fig. 15

Figs. 14 and 15.—"Drop" in Pin-pallet Escapement

cement them in exactly the same positions as before. Should a stone be broken or lost, a new one may be obtained from a clock-material shop and cemented in.

Worn steel pin pallets are best replaced with new ones. Generally they are driven in tight, and may be knocked out. New

pins must be very carefully made from steel wire, filed flat to size, and hardened, a good polish being put on finally.

In French pin-pallet escapements there is very little drop, and the teeth points are thin. This being so, a tooth just a little bent causes the pallets to catch it and the clock to stop. Therefore, in examining such an escapement it is not sufficient to try the drop on a few teeth; but it must be carefully tested on every tooth of the wheel for a complete revolution, and all faulty teeth straightened.

Worn pivots or pivot holes to the escape wheel or pallets will also cause an apparently correct escapement to catch and stop.

Another form of the French visible dead-beat escapement—the Brocot—is shown by Fig. 12.

A few clocks have pin-pallet escapements like Fig. 13, in which the impulse is on the wheel teeth, and the pallets are small, round, hard-steel pins. The pins wear rapidly, and when worn must be replaced with new ones filed up from needles tempered blue to allow of being filed. These escapements are adjusted like the other pin-pallet ones above described, and the really important point is the locking. The teeth must drop on the pins as in Fig. 14, just below the corner, and as little below as possible. If the drop is like Fig. 15, the pallets must be closed and brought a little nearer to the wheel.

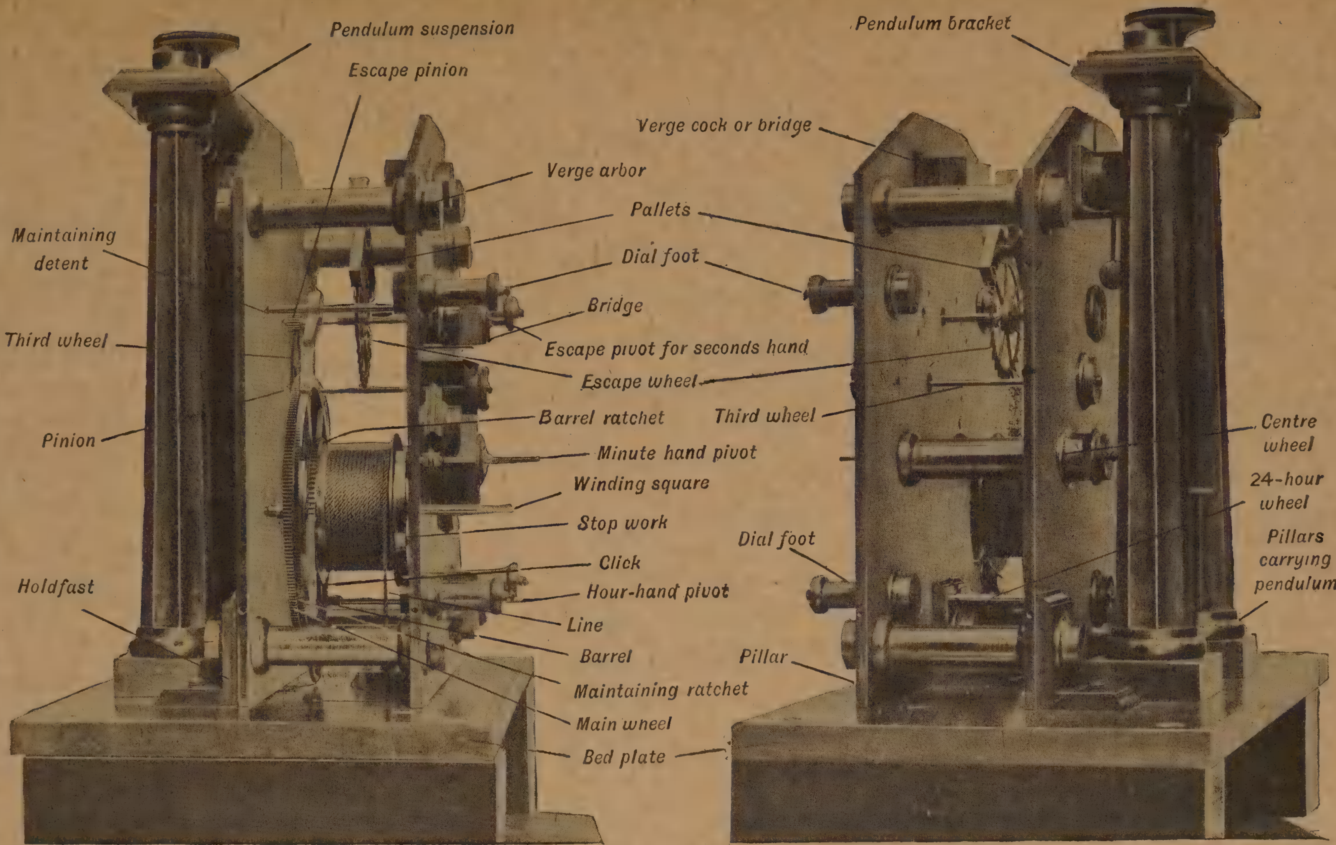
CLEANING AND REPAIRING REGULATOR CLOCKS

Vienna regulators are, without doubt, the best timekeepers to be had, with the exception of a fine seconds-pendulum regulator. Their great advantage lies in the possession of a long and fairly heavy pendulum and a carefully made "dead beat" escapement. They are driven by a weight, which is superior to a spring, in that the power does not vary when wound up fully or nearly run down, but is always the same.

The Escapement.—Figs. 16 and 17 show the movement, and Fig. 18 the form of pallet used in a regulator clock. It will be observed that the resting surfaces of the pallets, or their "locking faces," as clockmakers would say, are struck from the pallet pivots as a centre, and therefore the escape-wheel teeth, when resting upon them, neither advance nor recoil, but only move when they give impulse across the faces of the pallets. This form of escapement, invented by Graham, is admitted to be the best yet introduced for ordinary clocks; its only superior is the "Gravity," used in turret clocks and sometimes in the best regulators.

In Vienna regulator escapements the pallet bodies are often made of brass, in which the pallets lie in grooves. The pallets are curved pieces of steel, and held in place by clamping screws. When their faces become worn, the wear may be buffed out, and the pallet advanced by simply loosening the clamping screw. This obviates the necessity of softening and closing the pallets, as in those of English pattern, and is a distinct improvement. When the dead faces of these pallets become so worn that advancing them is not very satisfactory, the pallet may be reversed end for end in its groove, and thus made as good as new.

Vienna regulator clocks are, as a rule, very well made, have light wheels and small pivots, being driven by a comparatively light weight. This means that they must be kept fairly clean and well oiled; also that the pendulum cannot be expected to swing through a very large arc. As a rule, the pendulum swings very little farther than is necessary to allow the teeth to escape, and there is very little run on the locking or "dead" faces of the pallets. Therefore, in these clocks, always particularly try the locking of the teeth on the pallets. In many cases where they stop, the teeth lock too much; that is, they fall too far up the dead faces, and not near enough to the corners. This makes a larger swing of the pendulum necessary to allow them to escape, and the power not being sufficient to maintain it, the clock stops. In such cases adjust the pallets so that the teeth only just lock, and the clock will be nearly always cured. Fig. 19 shows a



Figs. 16 and 17.—A Regulator Clock Movement

tooth just locking properly; Fig. 20 shows a tooth locking too far up; and Fig. 21 shows a tooth mis-locking and falling on the impulse face instead of the locking face.

"Maintaining Work," etc.—It will be observed that there is "maintaining work" to keep the clock going while it is being wound. In a spring clock this is unnecessary, but in a weight clock, unless some such arrangement were provided, the act of winding would not only stop the clock for a minute or so, but would cause the escape wheel to travel backwards and double the error.

A careful examination of the barrel and main wheel will amply repay the worker. It will be seen that a ratchet and curved

Fig. 19

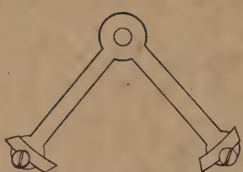


Fig. 18.—Vienna Regulator Pallets

Fig. 20

Fig. 21

Figs. 19 to 21.—Tooth Locking Properly, Too Far Up and Mis-locking Respectively

spring are interposed, and it is through this spring that the driving power reaches the clock. A pawl, or "detent," as it is called, falls by its own weight into the ratchet teeth, and, when the clock is being wound, prevents the ratchet and curved spring from being carried backwards; the curved spring in the meantime keeps the clock going until winding is completed.

Removing Movement, etc.—To remove the movement of a Vienna regulator undo the two set-screws just underneath the clock and draw the movement forwards. The pendulum will be left in the case and need not be disturbed. Hands and dial come off as usual. The plates and wheels, etc., must be polished with rottenstone and cleaned as in the ordinary French movement described in an earlier chapter. Repairs of any kind are seldom needed. The gut line, if broken, is easily replaced with a violin "A" string, purchased at a music-seller's, the method of replacing being self-evident.

Setting Up.—To set up a Vienna regulator, proceed as follows: First hang it upon a stout picture-nail, and adjust for upright by means of the pendulum and the enamelled scale at the bottom of the case, the pendulum when at rest just indicating zero on the scale. Then screw the two steadying screws, one each side of the bottom of the case, firmly into the wall. Finally, set in beat by means of the adjusting screw on the crutch, which can be easily manipulated without disturbing anything. In most clocks of this type, the seconds hand revolves once in about forty seconds.

CLEANING AND REPAIRING LEVER DRUM CLOCKS

Portable timepieces are controlled by means of a watch balance instead of a pendulum, and therefore partake partly of the nature of a clock and partly of that of a watch. The most frequently met with type is the familiar nickel-plated drum clock of American or German manufacture, the movement of which is shown in Fig. 22. The movement, on the whole, is similar to that of the cheap pendulum clock discussed earlier in this work, and it is cleaned and repaired in practically the same manner. The only difference of note is the escapement. To take a movement out of its case, unscrew and remove the two feet and take out a small screw or screws found at the top of the case, and the entire movement will then come out from the back. Before doing this, the winding buttons, etc., must be taken off by unscrewing in the reverse direction to that of winding, and the set-hands button pulled off. This liberates the back.

The Escapement.—This is an adapted lever watch escapement, there being a balance A (Fig. 23), which is really a fly-wheel mounted on pivots so as to spin quite freely, and attached to it is a hair-spring in such a way that when the balance is given an impulse it vibrates

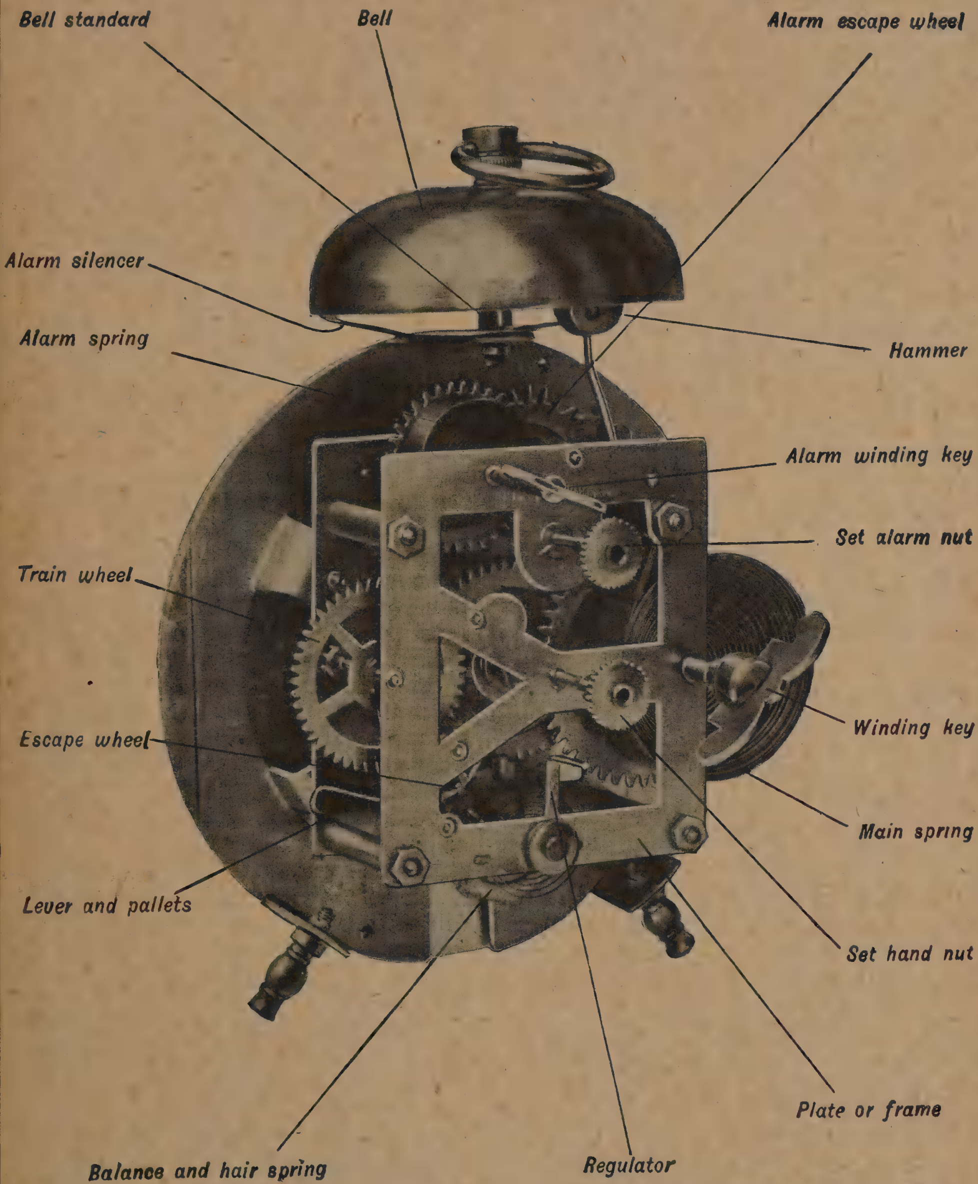


Fig. 22.—Movement of Ordinary Lever Drum Alarm Clock

backwards and forwards, moving a less and less distance each time, until it comes to rest. It thus acts in a similar way to a pendulum and forms a time measurer, because each vibration, whether long or short, is performed in a certain time. The balance and hairspring are connected with a suitable escapement, that, like a pendulum escapement, will give the balance a little impulse at each beat to keep it going, and at the same time allow one tooth to pass the pallets.

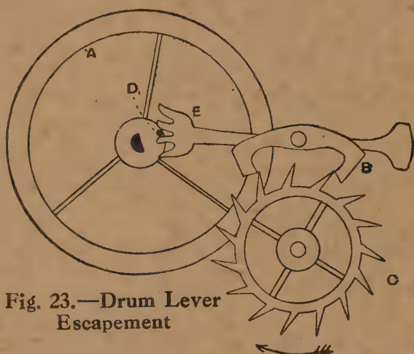


Fig. 23.—Drum Lever Escapement

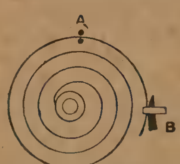


Fig. 25.—Hairspring

Fig. 24.—Lever Fork Action

The result is a timekeeper which is nearly as good as a pendulum clock, and which is portable, for clocks with balances may be moved or carried about in any position without greatly disturbing the working.

The common form of drum lever escapement is shown in Fig. 23. The escape wheel C and pallets B are of the dead-beat form, very similar to a French or American dead-beat escapement (already illustrated in this work). Instead of a crutch being attached to the pallets to work with a pendulum, there is a lever E (Fig. 23), at one end of which is a fork to give impulse to the balance through an "impulse pin" D. At the other end of the lever is a counterpoise to balance it. The impulse pin is set upright in the centre boss of the balance, and as it comes round enters the centre notch of the lever fork. This moves the lever a little, unlocking an escape-wheel tooth, and allowing it to give impulse. This impulse is transmitted by the lever to the impulse pin, and thus the balance receives a little push onwards. The balance continuing its motion, is at last brought to rest, and the hairspring causes it to return. The impulse pin enters the centre notch of the lever fork, unlocks a tooth, and the lever gets another impulse, and so on.

Between the impulses the escape-wheel teeth are locked, as in the English dead-beat escapement (see an earlier volume), and the pallets and lever do not move. The balance, also, is quite free to spin, the lever not touching it. The axis of the balance has a flat filed on it opposite the impulse pin, to allow the prongs of the lever fork to pass. The use of the outer prongs of the lever is to prevent the lever moving and unlocking the escape-wheel teeth between impulses. Fig. 24 shows what is meant, and represents the lever fork and the balance axis between two impulses. If the lever gets a shake or from some accidental cause comes against the balance axis B, the prong A will rest against the axis B, and the lever can get no farther until the impulse pin comes round and enters the centre notch, by which time the flat on the balance axis will be in position to allow the lever fork to pass.

Adjusting Depths or Actions.—There are two depths or actions that must be adjusted correctly. The first is the pallet depth or action between the escape-wheel teeth and pallets. This exactly resembles that in a dead-beat French or American clock, and should be adjusted to "lock," in precisely the same way. The second is the lever depth or action between the lever fork and the balance axis and impulse pin. The lever must have sufficient motion between its banking pins for the horn or prong A (Fig. 24) to be quite free of the axis of the balance, and have some shake. To test this, hold the balance

with the finger, half a turn round, as in Fig. 24. Then place a finger-tip or pair of tweezers on the lever counterpoise, and try the "shake" of the prong A against the balance axis. Let the balance come round, and hold it on the other side, trying the shake of the prong D in the same way. If they touch and have no shake, the balance cannot vibrate freely, and the banking pins must be bent outwards to give a little play. If the points of the lever prongs can pass the balance axis and seem too short, lengthen the lever by straightening up the bend in the lever a little.

Adjusting the Balance.—The balance must be adjusted in its bearings, so as to be quite free and have the least trifle of endshake; but it must on no account rock about. It is very important that the points or pivots of the balance are central, true, and sharp. Sometimes they merely wear blunt or rounded; at others they wear all on one side. In each case sharpen them up on an oilstone until they are true and sharp. In doing this the balance must be rotated a little as it is rubbed on the stone, to prevent flats being formed on it. A good way is to hold the axis in a pin-vice during the process. Or the pivot points may be sharpened up on emery buffs; but the result is not generally so good.

The Hairspring.—The hairspring (Fig. 25) is an important part of the escapement. It is passed at its outer end through a hole in a brass stud, and held in place by a tapered pin B. The outer coil then passes through a wire loop or between two pins A, which are set in the regulator. The spring should pass freely between these pins, and when the balance is at rest should stand between them, not touching either, as in Fig. 25. Then when the clock is going the spring will play evenly between them. The hairspring should also lie flat in the clock.

If properly "in beat," when the balance is at rest the impulse pin will be in the lever fork, and the balance axis, impulse pin, and pallet axis will be in a straight line. This can be adjusted by loosening the pin B (Fig. 25), and either letting out or taking up a little more hairspring, and pinning tight again.

Timing.—If one of these clocks gains while the regulator is at "slow," and the hairspring quite free between the regulator pins A, it may be made to go a little slower (up to five minutes per day) by bending the pins A wider apart and giving the spring more play between them. If the alteration required is more than this, the spring must be unpinned at B, and the centre brass collet turned round on the balance axis, so that when again pinned in and in beat the hairspring is longer. If such a clock loses, the reverse process can be followed, closing the regulator pins a little for a small alteration, and shortening the hairspring for a larger one.

Lubricating.—Before making any such alteration, see if the clock is clean and oiled properly, as a dirty clock or sticky oil will cause all sorts of errors. The parts requiring oil are the balance pivots and escape wheel and lever pivots, the pallet faces, and just a trace on the impulse pin. The regulator pins and also the hairspring where it passes between them must be perfectly clean and dry, or else they will become sticky, giving the spring a jerky action and causing the clock to gain.

Weighting the Balance.—If a clock cannot be made to go slow enough, even when the regulator pins are opened out and all the hairspring let out, weighting the balance by tinning it with lead solder will be effective. But after this it must be well washed in plenty of water to remove the acid, and the hairspring should be removed during the process. Or three holes may be drilled at equal distances through the balance rim, and pins or screws fitted to make it heavier.

Varieties of the Lever Drum Escapement.—Different varieties of this escapement are met with. Some have pin pallets, while others have lever forks or impulse pins of other forms; but the principle of all is the same. A watch lever escapement acts in exactly the same way as these drum-clock escapements.

Making and Erecting Tents

"Square" Camping Tent.—The simplest frame for a "square" tent (see Fig. 1) is that of a ridge-pole supported by two upright posts, the latter being about 2 in. in diameter, and having an iron pin let into the upper ends to project about $2\frac{1}{2}$ in. The ridge-pole, with upper edge rounded and dressed, may be made from straight-grained pine 2 in. by 3 in. About 8 in. from each end in the under-side bore a hole $2\frac{1}{2}$ in. deep, just large enough to take the iron pin (see Fig. 2), and near the ends another hole $\frac{5}{8}$ in. in diameter horizontally, into which fit an oak or beech peg 4 in. long to keep the rope guy from slipping off. Fig. 3 shows the toggle for tightening up the guys; two holes are bored about 4 in. apart in a piece of hard wood, through which the rope is rove as shown, and finished with a knot. The bight is dropped over a peg driven obliquely into the ground; these pegs should be about 14 in. long. The length of the spars has not yet been given, as it is better to cut them to the required length than to rip the canvas. For sewing the canvas, a "palm," two or three duck needles, wax, and twine are necessary.

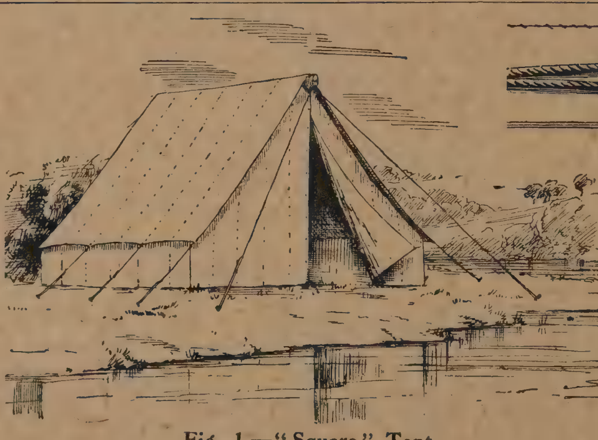


Fig. 1.—"Square" Tent

Fig. 4.—Method of Lacing Entrance Flaps Together

Fig. 3.—Tightening Toggle for Guy

Fig. 2.—Ridge-pole, Post, and Guy

Although single-roofed tents are uncomfortably hot in bright sunshine, they may be made exceedingly cool by spreading an awning on a separate ridge-pole,

leaving a clear 6-in. space between it and the tent roof for the air to circulate (see Fig. 1).

Of the many materials suitable for tent making, choose white cotton duck 18 in. wide, and the tent shown in Fig. 1 covers nearly 8 ft. square of ground. The roof will take six pieces 15 ft. long; join these by their selvedge edges with $\frac{1}{2}$-in. double seams, and hem the outer cloths down to form a 3-in. "table" on the selvedge edges. Then mark off on the other edges a 3-in. table, and sew down on the underside as before: this piece will now be rectangular, measuring 14 ft. 4 in. by 8 ft. $3\frac{1}{2}$ in., allowing 1 in. for correcting any irregularity on the cloth ends. Across the centre of this an extra piece of canvas should be sewn to stand against the chafe of the ridge-pole, and eyelet holes must be worked in every other seam at the eaves for guys, as shown. If the frame posts are 7 ft. 9 in. long, and their centres 7 ft. 9 in. apart, the top of the ridge will be 8 ft. from the ground, and the canvas roof will overhang the posts 2 in. or 3 in., so that when the side and end screens are sewn to the underside of the roof at 2 in. from the eaves, the latter will just come outside the posts. These may be 3 ft. high, 6 in. being allowed to hang on the ground for tucking under the tarpaulins. Six cloths will be required for each side, and the selvedge must be tabled down to make them 7 ft. $11\frac{1}{2}$ in. long.

It is convenient to have an opening at each end of the tent for change of wind, and the easiest way will be to make the ends in pairs; three cloths 12 ft. long joined by a $\frac{1}{2}$-in. double seam, and cut diagonally at an angle of 38°, will make one end and give 2 in. overlap for lacing and sufficient for tablings. The ridge angle is supposed to be 75°. The acute angle on each piece must be sewn down to allow room for the ridge-pole.

Fig. 4 shows a good method of lacing. Loops on one flap are passed through eyelet holes on the other, and are just long enough to reach to the next eyelet hole, as shown. Short pieces of whipcord sewn all round the eaves between the screen and roof will be very convenient in hot weather for tying up the side when rolled up. Then one or both sides can be instantly let down at will.

Bell Tent.—The bell tent shown by Fig. 5 was the British Army regulation tent, and is 14 ft. in diameter by about 42 ft. in circumference. It is made of unbleached tent duck. The plan, Fig. 6, shows the number of pieces required. There are twenty-two sections, each 10 ft. 6 in. long and 2 ft. 2 in. wide at the lower end, diminishing in a straight line each side to a point. The width includes the extra material required to form the lapped or laid seams. The last seam is continued only 4 ft. from the top, leaving the remainder to form the opening of the tent, as shown in Fig. 5. The end of this seam is strengthened by stitching an extra gusset piece on the face. The edges of the parts folded back are bound with wide webbing 3 in. across, containing brass or galvanised iron eyelet holes for lacing purposes. The webbing is also carried along the bottom edge on the under-side of the whole circumference. At the termination of each seam is stitched a piece of webbing 3 in. square, with folded edges, containing an eyelet hole, to which the stay ropes are fixed.

Near the apex of the tent three ventilators are formed (see A, Fig. 6). The canvas is cut and hemmed in the three sections, leaving a hole in each case about 8 in. long, 4 in. wide at the bottom, and tapered towards the top. The roof of the hole is formed by stitching the canvas round an iron hoop and along the sides. The hoop is made of $\frac{1}{4}$-in. round galvanised iron, and is 6 in. high by 6 in. wide. The apex of the tent is made into a hood and lined with stiff canvas, and into this is fitted the tent pole, which is rounded at the top end.

The wall B (Fig. 5) of the tent is 2 ft. 2 in. high, and is made of the same material as the cover. The upper edge is bound with webbing, and is stitched permanently to the tent cover along the dotted line shown in the plan. The lower end is bound with canvas, and in addition has coarse canvas, 6 in. wide, stitched along

the edge. The wall is held down with small pegs run through loops, made of strong line, attached to its lower edge, the space left between the edge and the ground being filled with the canvas edging, to prevent draught.

The tent pole is 3 in. in diameter, and

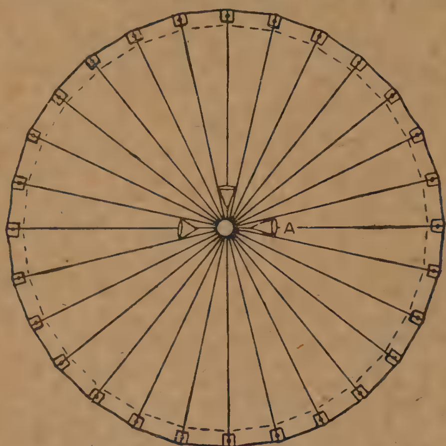


Fig. 6.—Plan of Bell Tent

is made in two parts, with a socket joint.

Ground Sheet.—For use with the tents here described a ground sheet is always desirable, and this can be made of strong canvas, prepared in the following manner: Procure 14 lb. of best black paint ground to a thick paste in oil, $\frac{1}{2}$ lb. of finely powdered litharge, $\frac{1}{2}$ pt. of thick boiled oil, 2 pt. of boiled linseed oil, and 1 pt. of outside oak varnish. Mix the black paint, litharge, and thick boiled oil to a paste, and thin down with the other ingredients. This preparation dries hard with a glossy surface in about ten hours; it should be applied as ordinary paint. Another method is to mix well together equal parts of raw, boiled, and thick boiled linseed oils, adding sufficient lampblack to colour the oil. This preparation takes longer to dry than the above and is not so glossy, but is more elastic and pliable, and materials treated with it can be folded or creased in any manner without cracking.

Many other colours may be used instead of black; for brown, use raw and burnt turkey umber; for yellow, use yellow ochre, chrome, or raw sienna; for red, use venetian or indian red; for green, use various shades of brunswick or permanent zinc greens.

To apply the dressing, spread the canvas on a flat surface and give two or more thin coats by means of an ordinary paint brush, allowing the first coat to dry thoroughly before applying the second. The drying is usually hastened by suspending the canvas on lines hung across a room

Fig. 5.—Bell Tent

having a temperature of about 100° F., paper or trays being placed underneath to catch the surplus oil that may drain.

Light Bathing Tent.—The tent shown by Fig. 7 was made and designed to carry on a bicycle (see Fig. 8) for a distance of a few miles and erect upon the beach for the use of two bathers. It is not large, being 5 ft. 9 in. from apex to ground, and covering 5 ft. 8 in. square. The materials are: Four cheap bamboo three-joint fishing rods; 5 yd. of unbleached calico 70 in. wide; screw-eyelets. The bamboo

rods, when packed up, measure 2 ft. 11 in., and the covering rolls up into a package 12 in. by 6 in. by 3 in., which can be strapped upon an ordinary carrier; but the same materials will make a tent 6 in. higher for the use of taller people, as there is a little material to spare. The fishing-rods consisted of three joints each 2 ft. 11 in. in length; but as this was too long for the purpose required, the slender top joints were cut down to 12 in., giving less spring and greater strength. They are, of course, light and springy, but lightness and portability are the chief points in view, it only being necessary to erect it for half-an-hour at a time, and that only in fine weather.

The four top joints of the rods have a string passed through their end rings and are tied together in a bunch permanently as shown in Fig. 9. The bottom joints have a screw-eyelet inserted 3 in. from their lower ends to tie the bottom tapes of the covering down. The calico covering is 5 yd. long and 70 in. wide, and Fig. 10 shows how it is cut up to form the tent. The base of each side of the tent is 70 in. wide less a small portion for the seam. The height is 7 ft. 6 in., and each side is a triangle like Fig. 11 (see also the plan, Fig. 12). About 4 in. or 5 in. is turned up inside at the bottom of each piece and divided into three pockets by vertical seams, forming corner pockets A A and a centre pocket B, in which to load sand or shingle to keep the sides down and weight the tent bottom, especially the corner pockets A A near the rods, to prevent the tent blowing over, as no pegs and cords are used.

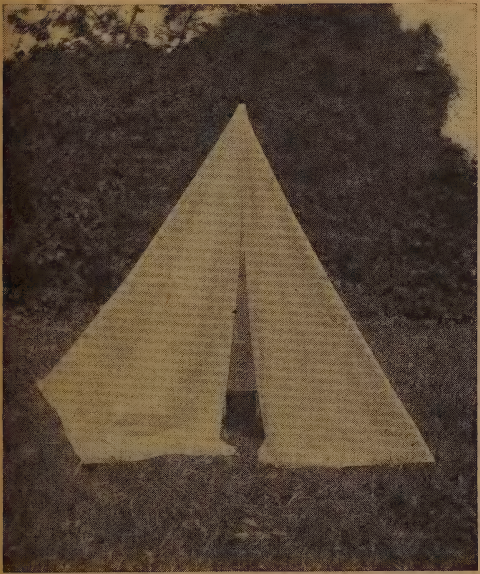


Fig. 7.—Light Bathing Tent Erected

Fig. 8.—Tent Packed on Bicycle

Fig. 10 shows how the material is cut up. The two sides are each in one piece. The back is formed by joining the two pieces cut from the left (A to A) by a seam up the centre. The front is formed similarly by joining the two pieces but from the right (B to B), except that the join only extends downwards 9 in. from the top point, and is then left divided to form a door and provided with one or two tapes for tying together when dressing. A tape is also sewn at each bottom corner for tying to the eyelets. When the diagonal seams are sewn up, uniting the

front, back, and sides into one complete covering, a small patch is sewn on at the top point to give strength where it rests upon the tops of the bamboos. To erect the tent, lay the rods on the sand and fit them together, inserting the bunch of top joints (Fig. 9) finally. Then erect the rods tripod fashion, unroll the covering and lift it over the stand, letting the top fall over the tops of the rods, where it will rest and take the weight of the material. The calico can then be tied at the bottom corners and the legs adjusted to tighten the material. It is then ballasted with sand or shingle, and is ready for use. The operation takes about five minutes or less. In packing up, the rods form a bundle which can be tied up and strapped along the bicycle-frame tubing. The covering can be placed on the carrier behind the saddle. As regards the sewing together of the material, the seams should all be lapped and be sewn down twice. At the top of the front door opening a small cross-piece should be put to give strength and prevent tearing upwards.

Fig. 9.—Top Joints Tied Together

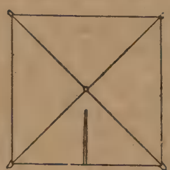


Fig. 12.—Plan of Tent

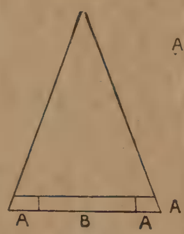


Fig. 11.—One Side of Tent

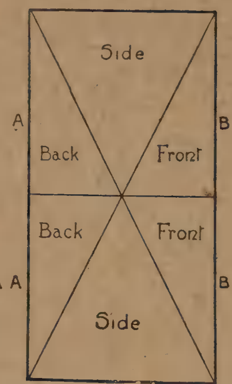


Fig. 10.—Cutting Out Material for Tent

Quick-drying Tar-varnish

For rough outside work where a large surface has to be covered and paint is too expensive—such jobs, for example, as old sheds and fences, galvanised-iron sheeting, etc. — it will be economical to use a tar-varnish. Made according to the following recipe, it will dry hard in a few hours. But a word of caution must be given to those who attempt to make the varnish themselves, as its ingredients are highly inflammable, particularly the coal-tar naphtha, and it is very important that there should be no naked flame near the vessel in which the varnish is being prepared: Melt together in a suitable iron vessel over the fire 7 lb. of coal-tar pitch and 1 lb. of coal tar; slowly add ½ lb. of quicklime, after which the temperature should be raised and the contents well stirred; this removes all traces of free acids. Now add 1 lb. of lampblack and ¼ gal. of boiled oil, stir well and allow to cool down, then remove well away from the fire, and add cautiously 3½ gal. of coal-tar naphtha. After being allowed to get cold the preparation is ready for use.

Making a Magic Lantern

The optical lantern here described has a good appearance, but is inexpensive to make. The general design will be gathered from Figs. 1 to 3. The only parts it will be found necessary to purchase are the condenser, the projecting lens, and a four-wick lamp, or an incandescent gas burner or other source of illumination.

Mahogany is probably the best wood for making the lantern. Well-seasoned, straight-grained wood must be used if the lantern is intended to be lasting, as the heat would soon find out the weak spots in inferior wood.

For the baseboard a piece of mahogany 1 ft. 1 in. long by $6\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. thick is required. Two pieces 10 in. long and $\frac{1}{2}$ in. wide are cut from the sides of the baseboard, as shown in Fig. 4. These two recesses accommodate the sides of the lantern. The part of the baseboard projecting in front of the lantern could have the top edges chamfered for appearance.

Making the Body.—For the sides of the lantern, two pieces of mahogany 10 in. long by $9\frac{3}{8}$ in. wide and $\frac{5}{16}$ in. thick will be required. These are fixed to the baseboard with screws, and should have large holes drilled in them for ventilating the body of the lantern, as shown in Fig. 1. The body of the lantern should be lined inside with tin, as a protection against the heat, so before finally fixing any of the parts together they must be lined with tin on the portions which form the inside of the body. The tin can be cut into pieces, two pieces $8\frac{1}{4}$ in. by $5\frac{1}{2}$ in. for the top and bottom, two pieces $8\frac{1}{4}$ in. by 9 in. for the sides, and two pieces 9 in. by $5\frac{1}{2}$ in. for the ends, and fastened in position on the wood with small nails or screws.

Figs. 5 and 6 show that the condenser is held in position by means of suitable-size holes in two pieces of wood, which form a thick hollow front for the lantern. In the measurements given the size of the condenser mount is $4\frac{1}{8}$ in. in diameter and $1\frac{5}{8}$ in. thick; but it is better to buy the condenser first, so that this portion can be made to fit accurately. Two pieces of mahogany 9 in. long by $5\frac{1}{2}$ in. wide and $\frac{5}{16}$ in. thick are required. A round hole $4\frac{1}{8}$ in. in diameter is made in both these pieces of wood, the centre for the hole being 3 in. from the top. Two pieces of wood $5\frac{1}{2}$ in. long by 1 in. square are fastened between these former two pieces, thus making a hollow front $1\frac{5}{8}$ in. thick, the thickness of the condenser, so that it comes flush with the front of the lantern body. The piece of tin lining the inside of the front will also require a hole through which to pass the condenser. The front, thus completed, can be placed in position, and fixed with screws through the sides and the baseboard.

For the top of the lantern a piece of mahogany 10 in. long by $6\frac{1}{2}$ in. wide and $\frac{5}{16}$ in. thick is required. In the middle of this and from one end a hole $7\frac{1}{4}$ in. long and $2\frac{1}{4}$ in. wide is cut as shown in Fig. 3.

In covering the top with tin it should be cut so that portions of tin can be turned up to cover the edges of the hole. The purpose of this hole is to accommodate the lamp chimney, and the lantern is so arranged that the lamp can be placed in the lantern with the chimney in position. This is a great convenience in use, as the lamp may be lighted and the flame regulated before it is placed in the lantern. Also, if anything should go wrong, the lamp can be withdrawn in a second. The top is fixed to the sides of the lantern with screws, and as these screws will be visible they should be fitted neatly. Brass screws should be used, and the heads should not be sunk below the surface of the wood, but should project slightly, so that on glasspapering they form a uniform surface with the wood.

For the back of the lantern a piece of mahogany $9\frac{3}{4}$ in. long by $6\frac{1}{2}$ in. wide and $\frac{5}{16}$ in. thick is required. This should preferably be made up with three pieces of wood, tongued and grooved and clamped together, as the heat would soon warp and twist a plain piece of wood. After lining the back with tin, it is fixed with hinges to the left-hand side of the lantern body, so as to form a door; but the hinges must not be fixed until after the sides are finished as described.

The sides of the lantern body are improved in appearance by having strips of mahogany glued on, as shown in Fig. 1. Four pieces of mahogany $9\frac{3}{8}$ in. long and four pieces 8 in. long, all eight pieces being 1 in. wide and $\frac{3}{16}$ in. thick, are required. These strips are glued on the sides of the lantern body to form a panel, as shown in Fig. 1, and fixed with fine panel pins. The upright strips serve the purpose of preventing the sides warping, in addition to being ornamental. The small holes in the front of the lantern (see Fig. 1) can be drilled now. These go right through into the hollow front, and are for the ventilation of the condenser.

Stage.—To accommodate the slide carrier, a stage is fitted to the body (see Fig. 1). Two pieces of mahogany $6\frac{1}{2}$ in. long by 1 in. square are screwed to the front of the lantern body, leaving a space of $4\frac{1}{2}$ in. between them, and on these a piece of mahogany $6\frac{1}{2}$ in. square by $\frac{5}{16}$ in. thick is fixed with screws. This latter piece of mahogany has a hole 4 in. in diameter cut in the middle of it, as shown in Fig. 2. A piece of stout tin (or sheet-brass) $7\frac{1}{2}$ in. long by $4\frac{1}{2}$ in. wide has a hole 4 in. in diameter cut in the middle of it, and the two ends are turned up at right angles for a distance of $\frac{1}{2}$ in., as shown in Fig. 7. Two pieces of clock spring are riveted or soldered to the back of the tin and it is then inserted in the stage, so as to exert a pressure on the slide carrier and hold it in position.

Bellows Focusing-attachment. — Probably the most easily made focusing attachment for the projecting lens is a bellows, as shown in Fig. 8. The bellows is 6 in. square, and should have an extension of about 7 in. Two pieces of bookbinder's cloth 2 ft. 1 in. long by 9 in. wide are glued together to give the requisite stiffness. When dry, the cloth is first folded fanwise in $\frac{1}{2}$-in. folds and pressed, the folds running along the longer length of the cloth. The cloth is next folded four times across the shorter length, the first fold being 3 in. from one end and the three others at a distance of 6 in. each. This leaves the last folded side overlapping the shorter side by 1 in. The overlapping portion is glued to the short side, forming a tube 9 in. long by 6 in. square. The $\frac{1}{2}$-in. folds previously marked and pressed in the cloth are now pressed again fanwise with the fingers, the corners being pressed into shape at the same time, like folding a parcel. This completes the bellows, and it may now be glued on to the front board of the stage.

Lens Board.—The front board for the projecting lens consists of a piece of mahogany $8\frac{1}{4}$ in. long by $6\frac{1}{2}$ in. wide and $\frac{5}{16}$ in. thick. This lens board might be made up with three pieces of mahogany, tongued and grooved and clamped together to the dimensions given to prevent warping; although if a piece of mahogany 6 in. long by $1\frac{1}{4}$ in. wide and $\frac{5}{16}$ in. thick was glued to the back, in the position shown by the dotted lines in Fig. 9, this

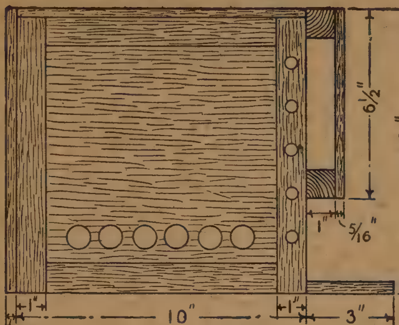


Fig. 1

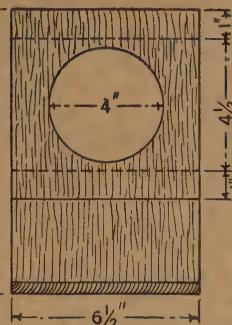


Fig. 2

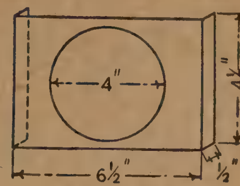


Fig. 7.—Tin Pressure Plate for Holding Slide Carrier in Stage

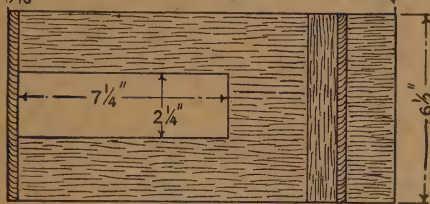


Fig. 3

Figs. 1 to 3.—Two Elevations and Plan of Lantern Body

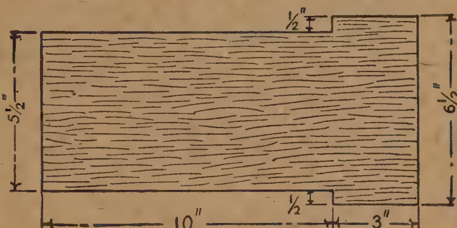
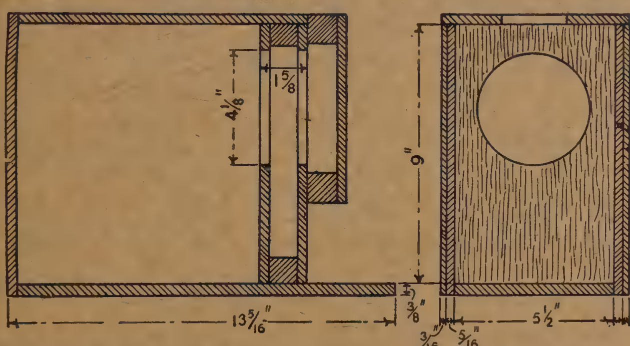


Fig. 4.—Baseboard of Lantern



Figs. 5 and 6.—Two Vertical Sections Through Lantern Body

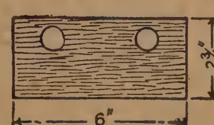
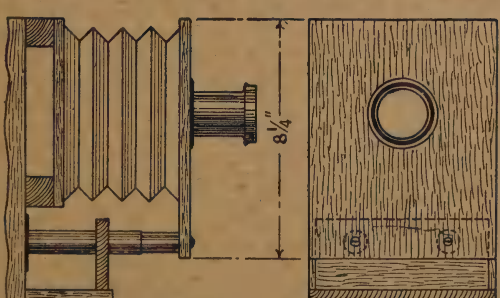
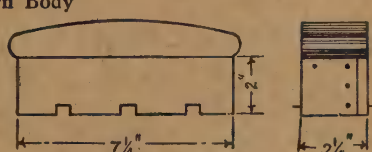


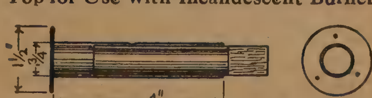
Fig. 12.—Support for Extension Tubes



Figs. 8 and 9.—Bellows Extension and Lens Board



Figs. 13 and 14.—Two Elevations of Top for Use with Incandescent Burner



Figs. 10 and 11.—Brass Extension Tubes

would answer the same purpose. Also, $\frac{3}{4}$-in. holes could be cut in the same piece of wood to grip the brass extension tubes, which would strengthen that part considerably. The hole for the projecting lens is cut with its centre $3\frac{1}{4}$ in. distant from the top, and the board is then glued to the front of the bellows.

Brass Extending-tubes.—The extension for the bellows is worked with brass tubes of $\frac{3}{4}$-in. diameter, as shown in Fig. 8. The arrangement of these tubes is shown in detail in Figs. 10 and 11. One tube 4 in. long slides smoothly, but not too easily, in another of a similar length, and two sets of these tubes are required. At the end of the larger tube a flange of thick brass $1\frac{1}{2}$ in. in diameter is soldered, as shown in Fig. 10. This flange has three holes drilled in it, as shown in Fig. 11, for attaching with screws to the front of the lantern. A plug of wood is tightly fixed in the end of the smaller tube, and to this plug the lens front is screwed. These tubes can now be fixed to the front of the lantern body, with their centres $3\frac{1}{4}$ in. apart and 2 in. distant from the top of the baseboard. To hold them more rigidly in position when the bellows is extended, a piece of mahogany (Fig. 12) is screwed to the baseboard, as shown in Fig. 8. This piece of wood is 6 in. long by $2\frac{3}{4}$ in. wide and $\frac{3}{8}$ in. thick, and has two $\frac{3}{4}$-in. holes cut in it, with their centres $3\frac{1}{4}$ in. apart, and 2 in. distant from the bottom, to grip the tubes.

The lens front is now fastened securely to the brass extension tubes with large screws, as shown in Figs. 8 and 9. The screws go right through the front into the wooden plugs in the tubes.

Accommodating Incandescent Gas Burner.—If it is desired to use an incandescent gas burner in the lantern, a tin top, as shown in Figs. 13 and 14, can be fitted. This fits in the hole on the top of the lantern. Two pieces of tin are required, one piece 1 ft. 8 in. long by 2 in. wide, and one piece 1 ft. long by $2\frac{1}{4}$ in. wide. The longer piece is bent to form a rectangle $7\frac{1}{4}$ in. long by $2\frac{1}{4}$ in. wide, which leaves one end overlapping by 1 in.; this overlapping portion is riveted together as shown in Fig. 14. Cuts are made along the bottom of each side of this tin top for $\frac{5}{16}$ in. up, so that small portions of the tin can be bent out at right angles, as shown in Figs. 13 and 14. These turned-up pieces of tin rest on the top of the lantern, and prevent the tin top from slipping through the hole into the body. The smaller piece of tin is bent in a curve, as shown in Fig. 13, and riveted to the former piece, as shown in Fig. 14.

Finishing Lantern.—The lantern can now be french-polished, or given three or four coats of brush polish, smoothing down with fine glasspaper between each coat. The metal parts can be coated with black varnish; or if brass has been used they should be lacquered.

If the condenser is placed so high in the lantern that its centre comes above the level of the flame in the lamp, as it may possibly be, it is an easy matter to put an extra thickness of wood on to the baseboard, inside the lantern body, so as to bring the lamp up to the right height.

Gas Pipes, Fires and Burners

Fixing Gas Fires.—The following particulars apply to the modern types of gas fires, these being independent structures usually standing in front of existing coal-burning grates. In the first place it may be stated that every kind of gas fire requires a chimney to carry away the products of combustion—the burned gases—and the chimney should be as effective as would be provided for a coal fire. Occasionally, a gas fire is used because the coal fire "smokes," indicating a defective chimney, but the practice should always be condemned.

It cannot be too widely known that when coal gas is perfectly burned—a good bunsen flame or a clean, hard-edged luminous flame, burning in free air—the products of combustion are practically innoxious. Modern makes of gas-steam radiators afford proof of this, for these are used without chimneys, and are freely allowed in places of amusement, schools, and other buildings, which are under the inspection and control of various public authorities. This perfection of combustion, however, applies only to heating devices that consume the gas perfectly, and this cannot be said of the gas fire or any appliance with which the flames impinge on surfaces at a much lower temperature than themselves.

With gas fires, and with some water-heaters, the flames beat on surfaces expressly provided for them to beat upon, this being particularly the case with a gas fire, and while some of these surfaces reach a high temperature, they are never nearly so hot as the flame, while parts might be called cool by comparison. When, therefore, gas flames play and impinge on such surfaces, combustion is not perfect, and it is sufficient to state here that the products—the burned gases—or one of them at least, should be got rid of.

When arranging to instal a gas fire, a special effort should be made to have its burned gases carried away by a brick chimney. Of course, the majority of these fires are stood in front of coal grates, the chimney of which is utilised as a matter of course; but when there is no chimney in the room where the gas fire is to come (as in a basement room, attic, built-out office, etc.), then every thought should be given to connecting to a brick chimney belonging to another room, if it is anyway possible. There may be a chimney in the wall, this coming from a room beneath or belonging to an adjacent room, or there may be a fireplace and chimney in the room above. In any case let it be remembered that reliance can usually be placed on what a brick chimney will do, whereas a metal pipe chimney is unreliable in most cases, and often a complete failure. A pipe flue is used with every success to connect a fire to a brick chimney, but for the whole chimney to be made up of metal pipe is nearly always disappointing. The metal is far

too good a conductor of heat to answer satisfactorily when exposed.

When arranging to fix a gas fire in front of a coal grate it is sometimes the practice to close the mantelpiece opening

Fig. 1.—Fixing Gas Fire Fireplace Opening Closed with Iron Plate

Fig. 2.—Fixing Gas Fire: Fireplace Opening Restricted but not Closed

by a sheet of iron, as in Fig. 1, the nozzle of the gas fire going through a hole which closely fits it. This is not a good plan, as it causes too much air to pass through the fire, while yet showing a decrease in the ventilation of the room. A 9-in. square chimney will, as a common rule, change the air of a 12-ft. room five or six times per hour, which is desirable if the room has, say, four people in it. This means about 130 cubic feet of air per minute, and this amount cannot be expected to pass through a 3-in. or 4-in. nozzle with success in every case. The consequence is that the room has its air-changes reduced, while the keen draught through the nozzle must have a cooling influence on, and reduce the heating efficiency of, the fire to some extent.

The better plan, unless some special condition prevents it, is to let the products discharge as Fig. 2. If the chimney has an ordinarily active draught in it, it need not be feared that the products will come into the room. Everyone knows that the smoke of a coal fire is set free some 18 in. below the chimney opening, yet, if the chimney is efficient, none of the smoke comes into the room. One well-known make of gas fire has its nozzle made pointing upwards at an angle of about 45 degrees, and with this the sheet-iron elbow shown in Fig. 2 is not needed. It will be seen that with Fig. 2 the gas fire can be pushed hard up against the grate, if desired, as there will still be openings around it to allow the necessary full volume of air to pass behind.

In the same way, if a gas fire is fixed in a room having no chimney of its own, but having in the wall a chimney from another room, then the fixing, if possible, should not be too sound. Fig. 3 illustrates what is meant, the "loose fitting" shown allowing a good volume of air to leave the room, for ventilating requirements, without causing a keen draught through the front hot part of the fire.

One word of caution as to Fig. 3 is to say that the fixer should ascertain what duty the flue is expected to perform besides taking off the products from the gas fire. If it is the flue of a fire grate or a range having regular use, consideration must be given to the possibility of this new aperture interfering with the work the chimney has been doing. The fixing of the gas fire in the manner shown is equivalent to making a fairly large hole in the chimney, and many kitcheners show a falling off in efficiency, if nothing

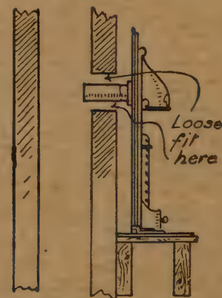


Fig. 3.—Gas Fire Flue Discharging into Chimney

worse, if such a hole is made. Fire grates, too, sometimes work less successfully if the chimney has an aperture made in it, besides which smoke may pass from the chimney through the aperture into the room. If the chimney in question has a regular duty to perform besides serving

for the gas fire, then the latter had better be fixed soundly (not loosely), and have a damper in the connection to be closed when the gas fire is not in use.

Connecting-up Gas Pipes.—The connecting up of gas pipes is a simple matter now that compo pipes have been generally discarded. The ironmonger can supply iron pipes to any length, with elbows, T-pieces, bends, etc., the pipes having external screw-threads at each end. To connect two pipes, a short sleeve, from 1 in. to 2 in. long, and threaded internally, is screwed half-way on one pipe and the other pipe then screwed into the projecting part, one or more special wrenches or pairs of gas pliers being necessary for turning the pipes. Before making the joint, the threaded parts of the pipes are smeared with a paint consisting of 6 oz. of paste white-lead, 2 oz. of red-lead in powder, and sufficient boiled linseed oil.

Ceiling pendants should have a ball-and-socket joint, which enables the pendant to swing in any direction. Before erection, the ball-and-socket joint should be taken apart, well greased with tallow at the movable joint, and, if the joint is found leaky. it should be ground in with a little powdered emery. this being afterwards carefully cleaned off. more tallow laid on, and the whole put together again and tested. Each end of the ball-and-socket joint is usually fitted with an internal thread, so that the pipe from the pendant can be screwed into one end, and a short piece of pipe, to pass through the ceiling, into the other. This short piece of pipe should be of sufficient length to reach a T on the pipe running across the joists, thus connecting the pendant to the gas supply, and should also serve to carry the weight of the pendant, the supply pipe being carried beyond the T with a short piece of pipe having a capped end, which will lie on the next joist, and so form an additional means of support. Should the iron supply pipe be running in the same direction as the joists, the best method to adopt is to fix what is known as a bridge-piece between the joists, and the simplest manner of doing this is to nail a narrow strip of wood to each joist, and rest the ends of the wooden bridge-piece on them. In the exact position over the hole in the ceiling, a hole should be drilled, through which the short piece of pipe from the ball-and-socket joint can pass, with a fairly close fit, and if a long thread be put on the upper end of the pipe, a back-nut can be put on before the union of the cap and lining is screwed on ; the back-nut should then be turned back until it forms a guard to the union to prevent the latter unscrewing.

Incandescent Burners.—If a newly fixed burner gives an unsatisfactory light, either there may be an insufficient gas supply or the mantle may be much too wide ; perhaps both conditions exist. In the first case the mantle will be well lit all round the bottom with the light getting worse towards the top. If two of the four air-holes in the bunsen tube are covered by the fingers, the light will at once improve. Therefore, either reduce the amount of air admitted, or increase the quantity of gas supplied. To reduce the amount of air. merely rotate slightly the ring or clip with which practically all modern burners are now fitted. To increase the gas supply, remove the burner from the fittings, and unscrew the bunsen tube, when the gas regulator nipple will be seen to consist of a brass tube having a soft white metal top with five small holes, which should be very slightly enlarged. Very handy for this purpose is a hat-pin, ground to a long taper and passed up from the under-side. When a mantle is too wide, one side only is incandescent, the other side hanging away from the gas ring. This fault is, of course, easily seen before the burner is used ; if, however, the mantle has been lit, the light can be improved by slightly lowering the mantle, and, as this is tapered, presenting a smaller surface to the flame.

It may be noticed that the brilliant light given by a new burner does not last, the light after a fortnight probably showing a marked decrease ; if kept in use the mantle top becomes coated in with soot and a smoky flame issues. The burners go wrong in a much shorter time if used in a room in which a fire is constantly

burning. The cause of this is simply dust, which is drawn in at the air-holes and carried up the bunsen tube. It cannot pass away owing to the gauze, to which it adheres, this preventing the gas getting away quickly enough to draw in the proper amount of air. To remedy this, take off the mantle and, with a small brush (an old nail- or tooth-brush), remove the dirt, blowing sharply through the gauze afterwards. Then replace the mantle, clean and replace the chimney, unscrew the bunsen tube, brush the nipple clean, and refix the top. If the mantle is covered with soot, leave the gas half on until the soot is removed.

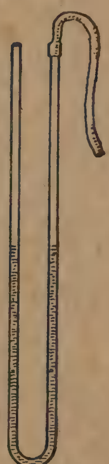


Fig. 4.—U-tube with Rubber Connection for Measuring Gas Pressure

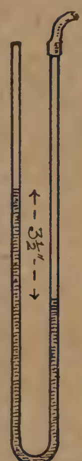


Fig. 5.—Water in Two Legs of U-tube standing at Different Levels

In the case of an old-fashioned type of burner, should the by-pass work badly—the by-pass light going out after the gas is turned on—one of the two set-screws on the side of the burner may have been inserted too far; in this case, after unscrewing a complete turn, the burner will most likely work. It is sometimes necessary to take out both screws and to remove the grease from the end of the hole.

When a Gas Tap Sticks.—The tap on a gas-bracket may, in the course of time, stick so badly that considerable force will be required to turn it. The trouble can be remedied in a few minutes. First turn off the gas at the meter. The tap is held in place by a screw inserted from the upper side of the pipe, and this screw needs to be withdrawn by means of a screwdriver. A small washer will then be observed, and this must be put aside carefully. A smart but not heavy blow with the wooden handle of the screwdriver will now drive out the plug. Sprinkle some knife-powder or fine emery on a rag and draw the rag gently up and down through the plug-hole in the pipe a few times, and also well polish the plug itself with the same rag. On replacing the plug, washer and screw, the tap will be found to turn quite sweetly, the ease of working being regulated by turning the screw a trifle in or out.

Finding Gas Pressure at Burner or in Pipe.—It is frequently desirable to know what pressure of gas exists at burners or in service-pipes to which some gas appliance is to be connected; and, failing the possession of a specially-made pressure-gauge, the following home-made device can be used with complete accuracy.

All that has to be obtained is a 12-in. to 16-in. length of small glass tube, of, say, $\frac{3}{16}$ to $\frac{3}{8}$ in. internal diameter. This can usually be purchased at a chemist's shop, and costs a few pence only. It requires to be bent U-shape, and this can be done in any gas flame (a blue flame for preference, as it is cleaner), and even if the bend is an ugly one it does not matter as long as it will let water pass through it.

Fig. 4 shows the bent glass tube, but it is extremely doubtful if a bend will be made, at the first attempt, as perfectly as the illustration shows. Sometimes, in making the bend, the tube is caused to be of smaller diameter, but for the present purpose this is not a fault; in fact, some are purposely drawn out quite small at the bend, it being said that this gives a steadier effect.

On one open end of the tube a piece of rubber pipe is slipped tightly, the other end of the rubber tube being slipped tightly on to the gas pipe or fitting, where the pressure is to be tested (see Fig. 4).

The glass U is about half filled with water, and the gas then turned on. While Fig. 4 shows the tube before the gas is turned on, Fig. 5 indicates what happens when the gas pressure be felt. The water, which at first stands level in both legs of the tube, will, under the gas pressure, descend in the leg which the gas enters and rise to a corresponding extent in the other leg. All that has now to be done is to measure the difference in height between the two water levels, and whatever it may be is the pressure of the gas per square inch. In Fig. 5 it is supposed that the difference between the two levels is 3½ in., and this would be as correct as the most expensive gauge could indicate it.

It remains to be explained that, up till a few years ago, gas pressures were always calculated and spoken of in "tenths." A "tenth" is the tenth of an inch, so that what is now called 1-in. pressure was then spoken of as ten-tenths pressure. The 3½-in. pressure indicated in Fig. 5 would be called thirty-five tenths. More recently, pressures are spoken of in inches, due to the fact that the days of low pressures are past, and when getting into higher figures, the tenths come awkwardly. In the time of the flat, luminous flame burner, it was common for the pressure in a house to be actually less than 1 in., and to speak with any accuracy, fractions—that is, tenths—were both convenient and necessary. With the mantle (bunsen) burner, particularly the inverted type, the pressure has to be (comparatively) high, and, as stated, the tenth is less often heard of. For what is known as high-pressure lighting, the gauge just described would be useless unless its arms were several feet long, as the special gas mains for these may serve the gas at 60 in. pressure. Large smelting furnaces may have the gas served to them at over 20 *pounds* pressure, this being the equivalent of 560 in. or 5,600 tenths, since a column of water that height and 1 sq. in. in cross section would weigh about 20 lb.

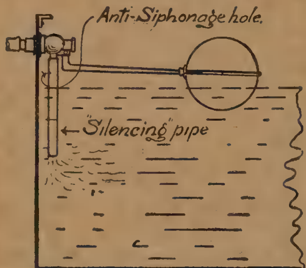
Adjusting Ball Valves

Ball valves in cisterns and waste preventers can easily be adjusted. First shut off the water, carefully examine the valve, and take to pieces. Some have only a split pin to fix the lever and support the plug, but others have several small brass screws, which must be taken out carefully to avoid breakage. When the plug has been removed, unscrew the portion at the end containing the washer if possible, and cut a new washer from a piece of rubber with a smooth surface, about ⅛ in. thick. Rubber with canvas insertion is the best; old or hard rubber is useless. See that the water passage is free from grit, clean the outside of the plug with a smooth file, and apply a little tallow. File up the end of the lever, and grease all moving parts; then fit together again. If the ball float contains water, make a small hole in it, and hold over a flame, the hole being at the bottom; the water will be driven out as the air expands inside the float. This hole and the one where the water entered can now be soldered; the latter hole will generally be found round the seam. Scrape bright, and use resin as a flux for a copper float, and spirits of salt for a zinc ball. Finally, bend the stem so that the tank does not fill and overflow.

Waste preventers sometimes have a valve at the bottom over the flush pipe, which, when worn, allows water to waste into the pan. This must be taken out and cleaned free from rust, and a new rubber washer put on the spindle, making sure that it beds level on the brass seat when in position. Care must be taken not to split the washer when stretching over the cast-iron valves. Valves with brass spindles are generally made to unscrew, and lead-topped valves have a nut on the spindle, which works in a guide in the valve seat; a little tallow on this spindle

will make it work freely. Sometimes the valve will leak a little, but this generally stops when the washer has soaked for a day or two.

Remedying Noisy Ball Valves.—When the water in a cistern is at its highest level and the ball valve is closed, the valve is noiseless; noises are heard only when the valve is open. It will be found, too, that noises do not occur when the valve is fully open (except the noise of running water), and that trouble of this kind is confined to those times when the valve is nearly closed. One common cause of noise, which has the character of a series of shocks or blows



Silencing a Noisy Ball Valve

rather quickly delivered, is brought about by the top surface of the water in the cistern being agitated, or having waves upon it, so that the valve ball is caused to rise and fall and shut and open the valve abruptly and repeatedly. The ball oscillates up and down, and there is obtained a series of shocks not very unlike those obtained in a hydraulic ram. The trouble is remedied by doing what is possible to keep the surface of the water undisturbed and smooth. The valve ball should rise quietly and evenly, and once it causes the valve to close it should remain closed. As a rule it is the delivery of the water from the valve which causes the surface disturbance, and to prevent this the use of a "silencing pipe" is resorted to. This is simply a pipe attached to the nozzle of the valve, the pipe extending down below high-water level, as illustrated on this page. It follows that if the water is delivered in this manner when the valve is near closing-point, the top surface cannot be agitated, and the closing of the valve will take place evenly and quietly. The dip pipe can be of lead, soldered to the valve, but in case anything occurs to set up siphonage (which would then empty the cistern), a very small hole is made above water line, thus preventing siphonic action.

Another cause of noise is the water-pressure being higher than the valve is suited to bear. The valve may open and close quite well, and act successfully in this respect, but when it is nearly closed a continuous droning noise is set up. This sound nearly always indicates that the valve is of an unsuitable kind, and the remedy is to change it for one suited for high-pressures.

A more obscure cause of noise is that of an oscillating ball due to shock occurring in the main service. Assuming that the valve is nearly closed, and the ball lightly floating on the water, a shock in the main, due, perhaps, to some large tap being suddenly closed or other cause, will exert a thrust upon the piston of the valve which must depress the ball in the water. As soon as the shock is over the ball will rise even higher than before, and then drop again. This is sufficient in some cases to disturb the water and start an oscillating motion which results in a series of shocks as first described. A remedy for this is not found in a "silencing pipe," as it is not the delivery of the water that makes the disturbance and rocking of the ball. A larger and heavier ball may end the trouble, while the provision of an air-vessel near the valve must afford relief. A change of valves is also a remedy, one of the equilibrium type being a probable cure.

The Proper Way of Using Enamel Paint

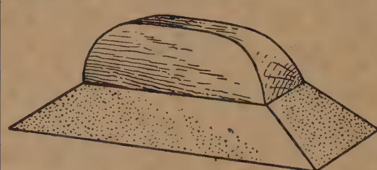
ONLY a few years ago enamelling a room was considered a tedious and difficult process, requiring all the skill at the command of the painter. It must be confessed that the old enamels were difficult of manipulation. Where one room was finished in this manner fifty are done to-day, and for this reason there was little opportunity for the decorator to get thoroughly acquainted with the material at his command. Now the number of proprietary gloss paints is legion, and it should not be difficult to select one suitable for any and every purpose. Add to this the fact that they are not only to be obtained in gloss, but in flat colours, capable with the aid of the stippler of giving an effect that is almost like satin in conjunction with a surface like polished glass.

Preparing Surfaces for Enamelling.—The surface intended to receive gloss enamel must be specially prepared, as, like varnish, the material will intensify any defect, and nothing looks more unworkmanlike than a shining surface full of inequalities or coarse streaks in the undercoats. The process of enamelling brings the worker to the subject of filling and filling-up, which terms must not be confused with stopping and puttying up.

The Filler.—Filling-up is a process well known to the carriage painter, as without it the flawless surfaces to be seen on the highest-class motor-cars could never be produced. The method adopted by the house-painter is somewhat similar, though, except in the finest finish, it is not carried so far. Perhaps the best course for the amateur is to buy one of the special fillers put up by firms like Harland and Son and Noble and Hoare, obtainable from colour merchants, using them according to the printed directions. These fillers may be bought in white or slate colour with special thinners. At least three coats should be given, each being allowed to get hard before the next is applied. When a sufficient body has been built up it should be rubbed down to a smooth surface with pumicestone and water, or with glasspaper doubled over a cork block. Alabastine is another good filler, several coats being applied, then rubbed smooth with glasspaper. A third filler is made from paste white-lead 1 part, dry white-lead ground in turpentine 1 part, and whiting ground in turpentine 1 part; thin for use with pale japan gold-size. A fourth is equal parts of paste and dry white-lead, the thinners being the same.

Making a Filler.—If the worker prefers to make his own filler, it must be thoroughly ground, so as to be free from grit, and used according to the following directions: Make the material into a thick, creamy paste, and use a broad stripping-knife for the purpose of spreading it. Begin on one of the panels, and taking up a fair quantity of the filler, draw the knife in one stroke from top to

bottom of the panel. Continue until the panel is covered, then finish as smooth as possible before beginning another part. If the knife gets clogged or dirty, so that it will not smooth the filler, dip in clean turpentine, and, while wet, finish the rough places. When drawing the knife down the panel or other broad surface, press on the middle of the blade with the fingers of the left hand, so that the filling is not wrinkled where the knife bumps by reason of the pressure on it being uneven. Each part must be finished as the work progresses, care being taken to make a surface as smooth as possible, so that very little rubbing down is required. This is very important, as where slovenly work is done and the worker depends on the subsequent glass-papering, a large amount of monotonous labour will be required to achieve the same end, which, by the exercise of a little care previously, would have been easy of attainment. If in working the filling dries off too quickly, add a little mixing varnish.



Felt Block for Rubbing Enamel

Precautions.—There is frequently the temptation to fill up only certain parts of a door or of a panel; but to get good results the whole of the broad work should be gone over. Sometimes there are indentations after the first filling operation, in which case repeat the process on the necessary parts, the first coat being quite hard. On new wood the filling should follow the second coat of paint; on old work previously painted, where necessary, after the first coat; and in each case allowed to get hard before being rubbed down. This may be done either with glasspaper or pumicestone and water; but glasspaper should be sufficient. The coat of paint following the filler should be fairly thin, and, if Alabastine has been used, should be composed of 3 parts oil to 1 part turpentine, so that it may penetrate the filling composition. With the home-made variety the colour may be sharper, the amount of turpentine slightly exceeding the linseed oil. The proper ground for enamel is a hard semi-flat; but this does not necessarily mean that each succeeding coat should be of the same kind.

Preparing Old Work.—On old work which does not require filling-up, wash and rub down as recommended in an earlier chapter. If it is a glossy ground, whether varnish or enamel, it must have sufficient rubbing with pumicestone and water to break or dull it before any paint is applied. The first coat may be mixed with 1 part of oil and 2 parts of turpentine; the second with 4 parts of turpentine and 1 part of oil. Allow to get thoroughly hard before enamelling.

Rub down old flatted work as in the previous instance. It may be remarked that it will cut down more readily than a gloss surface, but the work should be thoroughly done, as frequently flatted work is left coarse, owing to the fact that the true state of the surface is not so easily discernible to the uninitiated. Directly, then, enamel or varnish is substituted for flatting this coarseness is apparent. Work properly rubbed down need not afterwards have its surface spoilt if the paint is applied in thin coats. On the flatted surface mix the first coat with equal parts of oil and turpentine, the next 4 parts of turpentine and 1 part of oil.

Instead of using oil, enamel grounds may be made from white-lead, mixing varnish, and turpentine, or gold-size, varnish, and turpentine, with the addition of a very little driers; but whichever may be preferred the ground must be nearly flat.

The foregoing instructions apply to white-lead; but it may be well to state that zinc oxide constitutes a better ground. When zinc oxide is used there is no fear of enamel changing colour through the undercoat, and if only the coat pre-

vious to the enamel is zinc oxide, the enamel, if white, is likely to retain its purity for a longer period than when white-lead is employed.

Success in Enamelling.—More failures are made in enamelling than in flatting, especially on broad work, which constitutes the real test. The fault may be in the ground or in the enamel; but more often in a scant acquaintance with the brand being used. Good enamel should be free from grit, easy flowing, and free working. If easy flowing it will obliterate all brush marks, and if free working allow time in which to spread it. The last must be taken in a strictly comparative sense, for it is doubtful whether there is an enamel that will work with the same ease and certainty as ordinary oil paint. On the part of the painter, the essentials are cleanliness, quickness, and confidence. Many a door has been spoiled through the operator getting excited. The conditions required are freedom from dust and draughts; the tools, clean paint-pots, and brushes strong yet elastic and well broken in. The brush shown by Fig. 4, p. 31 (Vol. I.), is excellent for enamel, especially with a cripple or bridle attached. It is scarcely advisable to pour out a lot of enamel at a time, as the brushes are apt to collect dust and foul it. Only sufficient for immediate use should be exposed to the air at a time. Success in enamelling depends on the ground being quite hard, and in an equal degree to applying just the right quantity of material. If brushed out bare it will not flow together and obliterate brush marks, but remain just where and how the brush leaves it. If too freely it will run down in tears, or more likely sag; that is, tail down in ridges. Brushed too much, it will gather in lumps, and present a surface not unlike that of a cow-hide bag.

Enamelling a Door.—When enamelling a door, begin with the panels, then bring down stiles and cross rails together; if a joint is to be made anywhere, let it be at the bottom rail, cut in sharp and clean up to the stile. The mouldings may be put in last with a small sash tool or a fitch bound in tin. Once a door is enamelled it should not afterwards be touched. If, however, the enamel is inclined to run at the corners of the mouldings, lightly stipple the treacherous part with a clean, dry hog-hair fitch. This is the limit to re-touching that is likely to be successful. Very fine effects can be obtained by the use of gloss and flat enamels in conjunction on the same door, as flat panels and glossy stiles. The flat enamel can be applied over the same ground as the gloss. For walls and on ceilings it looks well, but for broad surfaces is best stippled.

Felting-down.—Where great durability or a special finish is required, it is usual to apply a second coat of enamel after the first is thoroughly hard. Ample time, therefore, is necessary between the coats, as the first will need felting or otherwise cutting down before the second application of enamel. The usual method is to felt down with fine pumice powder, using the felt block shown on p. 318 as a rubber. The powder must be free from grit, or fine scratches will result and show through the subsequent coat of enamel. To felt down, all that is required in addition to the articles mentioned is a pail of clean water, a chamois leather, and a soft sponge. The powder may be in a saucer, so that when dipping the damp rubber into the powder enough may be taken up for immediate use. If when damping the work the water cisses—that is, runs in rings—the slightest touch of pure castile soap will prevent this. Begin with one of the panels. Damp it all over with the sponge, dip the rubber into the pumice powder, and with a light, circular movement go all over the panel. Do not hurry the work, or rub with too dry a felt, but finish as proceeding, sponging off and drying up with the leather. The amount of rubbing down will depend on the surface dealt with and desired; but it should be necessary only to remove specks of dirt or grit. If every trace of pumice is not removed in washing, the enamelling brush will distribute it over the entire surface. "Steel wool" is an alternative to pumice powder and obviates the possibility of grit.

The Wood-turner's Lathe and Tools

WHILST the amateur, with whom floor space is generally limited, frequently prefers to purchase an iron-framed lathe rather than make himself a more cumbersome one in wood, it must be explained that the practical wood-turner's lathe often consists of a horizontal wooden framing, termed the lathe bed (to carry the headstock and poppet), which is supported on wooden standards. The last-mentioned are provided with bearings to carry the flywheel shaft, and they have elongated "feet," which at the back carry the tailpins for the treadle-pivot bar. The lathe feet should be fixed to the workshop floor with iron angle plates attached with stout screws.

In choosing the position for erecting the lathe, it is important to place it so that a good light falls on the work. A window with a northern aspect is best, as being freer from the glare of sunshine, which is very trying to the eyesight, especially when turning fine, delicate work which requires careful tooling. Therefore the lathe should not be placed in a corner, but fitted up so that, if possible, an equally good light falls between the headstock and poppet, that is, the full length of the lathe bed.

An advantage of the wooden framing, besides the obviating of the risk of injuring the keen-edged tools, which is apt to occur with metal framings, is that the wooden bed may extend to 6 ft. or 8 ft. in length, which is a convenience in chucking extra long jobs, such as bedposts. The extra length of the lathe bed should be supported with uprights fitted similarly to those that carry the flywheel.

A Wood-frame Lathe Described.—The construction of the wooden framing is shown by Figs. 1 and 2, which give front and end elevations of the lathe. The framing is of ordinary white-pine battens, $6\frac{1}{2}$ in. by $2\frac{1}{2}$ in., the standards A being either mortised and tenoned into the feet B, or, as shown, shoulder-checked and bolted to the feet with $\frac{1}{2}$-in. snap-headed bolts. The upper ends of the standards, as shown at C (Fig. 2), are shouldered, and the battens which form the bed D are firmly bolted together (with a tenon between of such width as to form an easy sliding fit for the print on the under side of the poppet), as shown at D (Fig. 1). (So as to show the fittings, etc., to as large a scale as possible, the lathe bed D has been curtailed.) The framing should be prepared from well-seasoned battens, planed straight and square, both for appearance and correct adjustment of position for the bearings of the flywheel and treadle pivot E and F, the strengthening metal plates of which should be fitted on the standards and feet before finally bolting the framing together.

The flywheel is of the flat-rimmed style, driving a flat $1\frac{1}{2}$-in. leather belt G to a two-speed wooden pulley on the lathe mandrel H. The flywheel should be heavy rimmed, and it is an advantage to have the rim loaded to carry the crank by the "dead

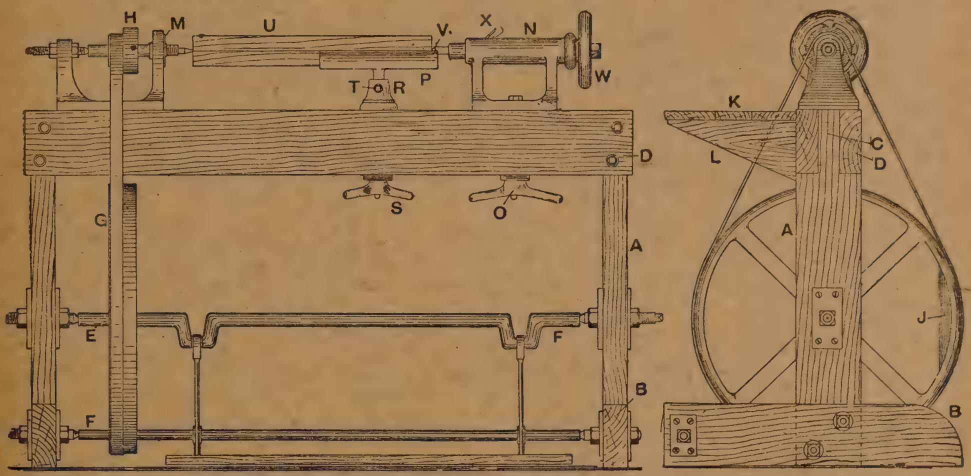
centre." The wheel is keyed on the crank, so that when it stops revolving, and the loaded side J (Fig. 2) assumes its normal position, the treadle is always in position to start the lathe with a thrust of the foot. Moreover, the increase of power gained by the momentum of the loaded flywheel is often an advantage when heavy work is being turned.

The lathe is also conveniently rigged up at the back with a bench or table attachment, which is very useful for keeping chucks and other small appliances at hand. As shown in Fig. 2, it is simply a platform of boards K nailed on brackets L, which are likewise fixed to the back of the lathe bed, a hole being cut through the platform for the driving belt.

The lathe headstock M is bolted firmly to the bed, with the mandrel pulley in alignment to the flywheel. The poppet N is adapted as a movable centre, and can be slid along the lathe bed to suit any length of work the lathe will take in between the centres. It is temporarily fixed to suit the special job on hand by means of the holding-down bolt and wing-nut O. The poppet is fixed by twisting the wing-nut with hand-tight pressure against the oblong iron washer, which takes bearing below the lathe bed, and thus holds the poppet firmly.

The T-rest P, which supports the turning tools, is adjustable for height in the socket by means of the pinching-screw T; and the socket R is also movable, both longitudinally and laterally, on the lathe bed to suit the work. It is temporarily fixed for each job, and may require to be removed into different positions with the wing-nut S, the same as the poppet.

Fig. 1 also shows a square rod of wood U, chucked between the prong and the poppet, just as the lathe would be set ready to begin the turning operation.



Figs. 1 and 2.—Front and End Elevations of Wood-turner's Lathe

Fitting up a Wood-turner's $7\frac{1}{2}$-in. Centre Lathe.—Figs. 3 and 4 illustrate a lathe which is built on the same lines as the above; they show a front elevation of the lathe and an end elevation of the framing only. Scantling $5\frac{1}{2}$ in. by $3\frac{1}{2}$ in., or even lighter stuff, should make a substantial bed, the length of which should be 6 ft. The 30-in. diameter flywheel, with 20-in. diameter driving pulley attached, suggests that the 3-in. and 6-in. diameter speeds on the lathe cone pulley are driven from the 30-in. flywheel, and the 9-in. speed pulley from the 20-in. driving pulley. The latter will give a slow lathe speed, but much more power for heavy work, such as boring and turning cart-wheel naves, felloes, etc.; but it will perhaps be advisable to use two different

driving belts for the purpose. A $1\frac{1}{2}$-in. belt for the quicker speeds would do very well, and it could be fitted with a simple buckle-joint for quickly altering to suit the 3-in. and 6-in. speeds; but it would be unadvisable to use anything lighter than a 2-in. wide belt for the slow speed for heavy work.

The uprights A may be of 3-in. by 9-in. red or white pine, which are checked as shown in Fig. 5, the tenons B being of such thickness as will bring the shears close enough together, so that the guide prints of the poppet will slide easily between without side-shake. Fig. 5 shows the standard shoulder and one-half of the bed butted against the tenon; but, if preferred, for further strength the tenon can be left thicker, and the cheeks of the shears checked out correspondingly. Fig. 6 shows details of the joint of the standard foot. Ordinary white pine, $6\frac{1}{2}$ in. by $2\frac{1}{2}$-in. batten stuff, will do well enough for the feet, and for appearance they should be nicely rounded off at the front ends as shown at C (Fig. 4).

In fitting together, the distance between

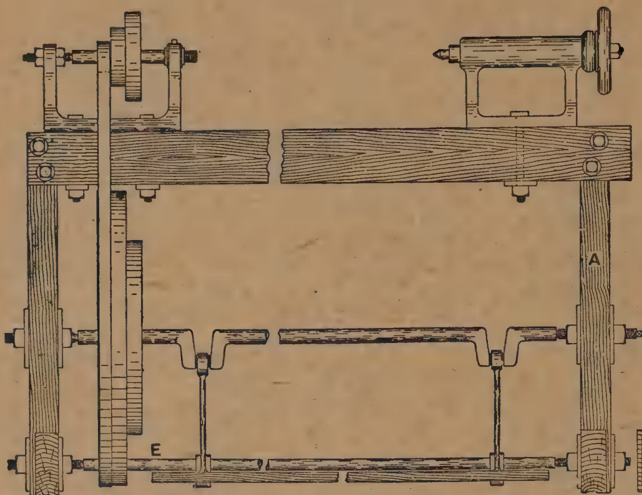


Fig. 3

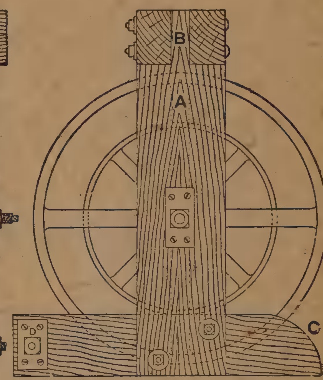


Fig. 4

Figs. 3 and 4.—Front and End Elevations of Wood-turner's Lathe

Fig. 8

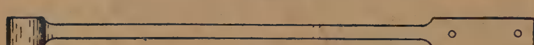


Fig. 9

Figs. 8 and 9.—Two Views of Treadle Arm

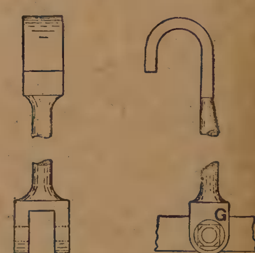


Fig. 10 Fig. 11

Figs. 10 and 11.—Two Elevations of Pitman or Connecting Rod

Fig. 5.—Upright Jointed in Lathe-bed

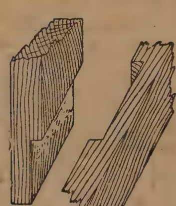


Fig. 6.—Joint of Lathe Standard Foot

Fig. 7.—Iron Plate

the standards will be governed by the length of the crank, so that the inner faces of the standards are about 5 in. or so more apart than the extreme length of the crank, to allow clearance at the ends for manipulating the crank tailpins, nuts, etc., as shown in Fig. 3. In boring the holes for the crank tailpins, exact measurements are necessary, and the hole centres should be marked and bored from both sides of the standards to keep the centres in alignment. Malleable iron plates are fixed on both sides of the standards to take the nut pressure, and also to support the tailpins centrally. The plates may be made 6 in. by 3 in., and $\frac{3}{8}$ in. thick, with centre holes to suit the diameter of the tailpins, and four drilled and countersunk holes for attaching to the standards with stout screw nails. Should it be thought advisable, on account of the heavy fly-wheel, to fasten the plates with small bolts and nuts, the plates must be carefully bored in pairs, to facilitate their bolting on the standards. The plates are shown in Fig. 7, and in fixing them the tailpins are inserted through the holes in the standards. The plates are then adjusted in position (on the tailpins), and the holes scribed on the standards through the drilled holes in the plates. Should they be fixed with screw nails, the plates

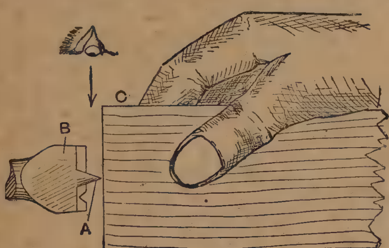


Fig. 12.—Prong and Poppet Chucking

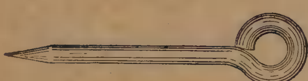


Fig. 14.—Marking Point

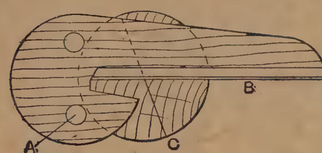


Fig. 16

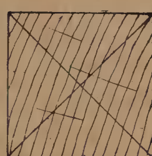


Fig. 13

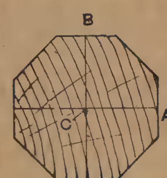


Fig. 15

Figs. 13, 15 and 16.—Methods of Marking Centres

can be set awry to permit the nails passing each other.

The tailpins for the treadle-rocker are fixed in the same manner through the standard feet as shown at D (Fig. 4). The treadle-bar E (Fig. 3) is a straight 1-in. iron rod with countersunk end centres for the tailpins. Figs. 8 and 9 give plan and elevation of the treadle-arms; they can be fastened on the treadle-bar with pinch-screws, or made as shown with a key-set and keyed on the bar. Fig. 9 shows how it is forged and drilled to support and fasten the treadle-board. It is about 5 in. wide and about $1\frac{1}{8}$ in. thick, fixed with $\frac{1}{4}$-in. bolts or stout screw-nails from the under-side.

Figs. 10 and 11 give front and side elevations of the pitman, the top being flattened and bent into a hook as shown for crank connection. The bottom end is fashioned as shown in Fig. 10, while G (Fig. 11) shows how it is attached by means of a bolt and split cotter-pin to the treadle-arm.

Figs. 1 to 4 are reproduced to a scale of $\frac{5}{8}$ in. to 1 ft.; Figs. 5, 6, and 7, $1\frac{1}{4}$ in. to 1 ft.; and Figs. 8 and 9, $2\frac{1}{2}$ in. to 1 ft.

Centering the Work.—The habit of truly centering the work (see Fig. 12) should be one of the first acquirements of the beginner. He may take the centres

of square rods by drawing pencil lines diagonally from corner to corner across the ends, as in Fig. 13, and then pricking the centre of the lines with a marker (Fig. 14). This marker is made from a 5-in. or so length of $\frac{1}{4}$-in. steel wire, eye-formed at one end and ground to a sharp point. It is chiefly used, instead of a lead pencil, for marking lines from a template on the revolving wood in spacing groups of beadings for turning.

Another and surer way of taking the centres is by means of the ordinary marking-gauge. The gauge is more correct than the method of diagonal pencil lines, and also much quicker when a number of similar sized pieces are marked at the same time, and it is equally suitable for square or octagonal stuff. The marking point of the gauge being set to half the thickness of the stuff, the centre is scribed from the faces A and B (Fig. 15), and the bisection of the lines C gives the true centre for chucking.

In the case of cylindrical work, the centre square is the proper instrument for indicating the centres. The centre square is easily made from a piece of mahogany $\frac{3}{16}$ in. or so thick, with two pins A (equidistant from the working face of the blade B) in contact with the arc of the work C, which is centred by drawing two or more crossing lines, as shown in Fig. 16.

Prong-chucks. — The experienced turner usually has no need to mark the centres. The sharp point A of the prong-chuck, as illustrated in Fig. 12, projects beyond the driving wings B, and enables him (on taking the square rod of wood C in his hand and forcing it very slightly on the prong point) to easily judge the centre. Then a tap with the hammer on the end of the rod fixes it on the prong, and the poppet centering, similarly done, finishes the chucking operation. Indeed, for light repeat work, when the lathe is power-driven, the work is often thus centred and finished without stopping the lathe.

Fig. 17 shows a style of prong-chuck used for chucking prong and poppet work that is bored before turning. The wings are similar to the ordinary prong, but instead of being finished with a sharp, tapered centering point, the latter is turned into a parallel pin about $\frac{1}{2}$ in. long, as at A, the diameter to suit the bored hole as indicated in section at B. The other end of the wood, if the hole B is bored right through, is supported by the poppet centre as at V (Fig. 1). Prongs of this kind are made with pin points of different diameters to suit various sizes of bore.

Two sizes of prong-chucks, which are made of steel, are handy, one 1 in. across the wings, and one $\frac{5}{8}$ in. wide for small work. These fit into tapered holes in the mandrel nose as indicated in Fig. 18, in which the dotted lines through the mandrel A represent the fitting of the shank of the prong B. A side view of the prong-chuck is shown by Fig. 19.

Screw-chucks.—There are numbers of different kinds of chucks (many are made by the turner himself to suit special purposes) for holding work which must be, or is more conveniently, held by one end, as in turning the inside of hollow work, or in finishing work in which the poppet centre would be disadvantageous. However, the beginner need only be concerned about the screw-chucks and the cup-chucks, with the assistance of which, along with the prong-chucks, a great variety of plain turning can be done.

The screw-chuck is usually made of cast-iron, the boss being bored and screwed with an internal thread for screwing on the nose of the lathe mandrel, which is, of course, externally threaded close up to the collar. The mandrel screw usually projects an amount equal to its diameter, as shown in Fig. 20, in which A indicates the screwed nose of the mandrel, and B the section of the screw-chuck. Screw-chucks are made in sizes to suit large and small jobs, 5 in. in diameter being a useful size for ordinary heavy work; the screw should be of steel, screwed and riveted into the chuck, with the projecting point finished tapering for chucking the work as at C. The work is chucked by boring a suitable size (about $\frac{3}{16}$ in. diameter) hole for the taper screw, and then screwing it on until the work butts

tight and square to the face of the chuck. The hole indicated at D (Fig. 20) is for inserting a "tommy" to facilitate screwing the work on and off, and also the unscrewing of the chuck from the lathe mandrel, flats being filed on the mandrel so that it can he held with a spanner.

similar articles. It is made with flattened sides to fit a spanner.

Cup-chucks.—Cup-chucks are made from cast-iron in different sizes as required, the work in this case being chucked by driving it firmly in the chuck. Two handy sizes of cup-chucks for the beginner

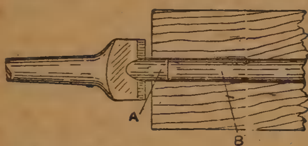


Fig. 17.—Prong-chucking Bored Work

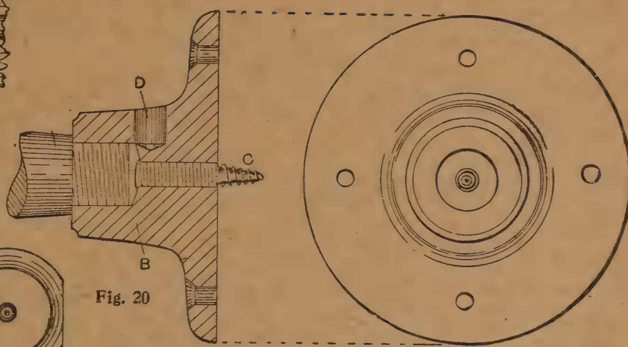


Fig. 20

Fig. 21

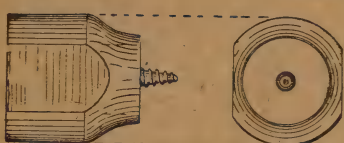


Fig. 22 Fig. 23

Figs. 20 to 23.—Taper Screw-chucks

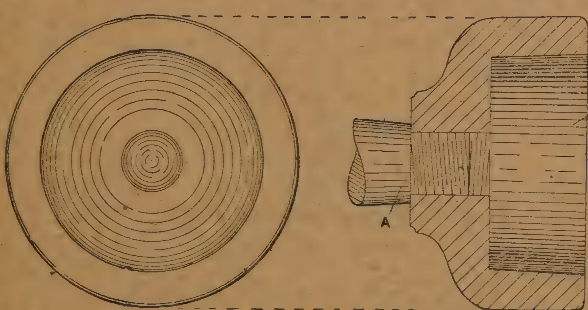


Fig. 24 Fig. 25

Figs. 24 and 25.—Cup-chuck

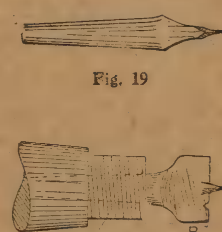


Fig. 19

Fig. 18

Figs. 18 and 19.—Prong-chuck

Besides the taper screw, the larger chucks are also provided with holes drilled through and countersunk at the back (see Figs. 20 and 21) for heavy work, which is generally held by wood screws.

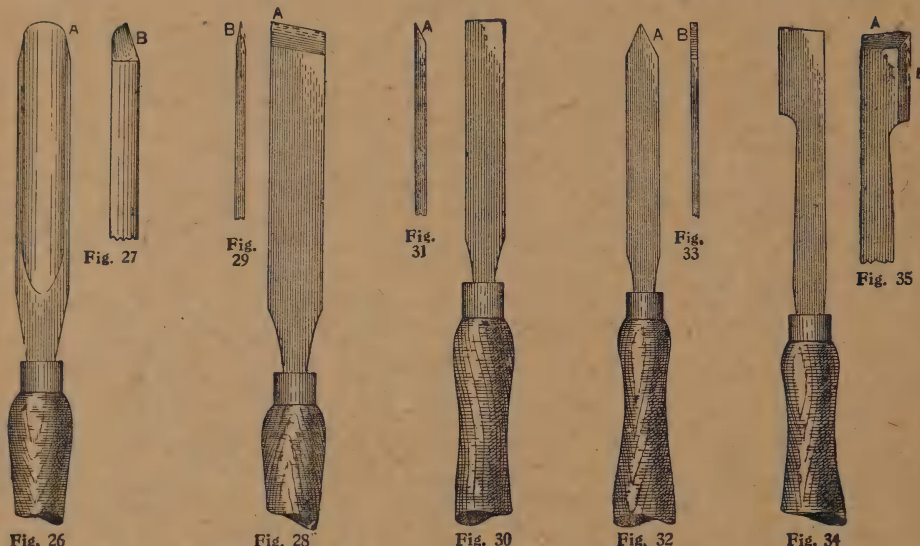
The small screw-chuck (Figs. 22 and 23) can be made of cast-iron, and, being only about $1\frac{3}{8}$ in. in diameter on the face, is very handy for turning small vases and

will be one 2 in. and one $3\frac{1}{2}$ in. internal diameter, both chucks being adaptable by driving in tight-fitting hardwood stoppers, which can be easily bored and hollowed out to form suitable chucks for intermediate sizes. Fig. 24 shows the plan and Fig. 25 a section of the cup-chuck screwed on the mandrel nose A, while B shows the recess into which the

work is chucked. It may be mentioned that, with this simple kind of chuck fitted with hardwood stoppers, centre-bits, nose-bits, drills, etc., can be chucked for boring any kind of work within the power of the lathe.

Gouges.—The cutting tools chiefly used in wood turning are gouges and chisels. Gouges of various sizes are used in the preliminary work or roughing-out, and also in turning and finishing hollows between broad and narrow, but the stouter and more substantial gouges are preferable, as being less liable to spring.

Chisels.—The wood-turning chisel is used for finishing the roughly gouged wood, being equally usable on both of its broad sides (on the T-rest) for "skinning" over, or chiselling to right or left hand; and also with its narrow edge on the rest in rounding beadings to right and left. It is ground with equal bevel from



Figs. 26 and 27.—Turning Gouge   Figs. 28 and 29.—Turning Chisel   Figs. 30 and 31.—Scraping Chisel   Figs. 32 and 33.—Parting Tool   Figs. 34 and 35.—Side Tool

groups of beadings, etc. They can be obtained in sizes from $\frac{1}{8}$ in. up to 2 in. or more in width. Three gouges, $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{3}{4}$ in., will suffice for the beginner's requirements. A point to note is that the gouges should not be ground to long-snouted points. Figs. 26 and 27 respectively give front and side views of a wood-turning gouge ground to correct shape for general work. Instead of being long-pointed, the gouges should be ground to a large radius on the point, as shown at A, and to a bevel of about 20° from the back of the tool, as at B.

There are two kinds of turning gouges, both of its flat sides, and also with the cutting edge at an angle, as in Fig. 28. The angle of the cutting edge may be about 10°, which provides a sufficiently "long corner," as shown at A, for ordinary work. As shown in the edge view (Fig. 29), the chisel is ground from both sides to an angle of about 10°. The chisels, like the gouges, are made in different widths up to $2\frac{1}{2}$ in.; but three should be sufficient for the beginner, one each of $\frac{3}{8}$ in., $\frac{3}{4}$ in., and 1 in. or $1\frac{1}{8}$ in. will be found useful sizes for many kinds of work.

Scrapers.—The turning chisel being

bevel-ground from both sides is unsuitable for clean scraping, especially for smoothly finishing side wood, which, of course, requires special treatment, and for which the ordinary chisel could not effectively be used owing to the position of the cutting edge.

Stout turning chisels of suitable widths, as shown in Fig. 30, have the bevels ground off only on one side, as at A (Fig. 31), to an angle of about 20°, and the edge turned over from the back to form a scraping edge. Two of these scrapers, $\frac{3}{4}$ in. and $1\frac{1}{2}$ in. wide, will be found suitable for most jobs which necessitate a "scraping" finish.

Parting Tools.—The parting tool is shown in side and edge views by Figs. 32 and 33. As its name indicates, the parting tool is used for cutting off finished cup-chuck work, and also for "cutting in" the spaces between groups of beadings. Two of these tools for fine and heavy cutting will be found most useful, one $\frac{1}{16}$ in. and one $\frac{1}{8}$ in. thick, ground to a bevelled point as shown at A and B.

Side Tools.—The side tool is shown in front or top and back views by Figs. 34 and 35, and it has the bevels ground off from the back at the point A and the side B to give the two cutting or, rather, scraping edges. The side tool has the edges turned over (similar to the scraping chisel) to form scraping edges for finishing the cylindrical insides of boxes, vases, etc.

Fig. 40


Fig. 36

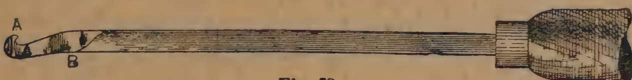


Fig. 39

Figs. 39 and 40.—Hook Tool


Fig. 38

Fig. 37

Figs. 36 to 38.—Diamond-point Tool

Fig. 41.—Hand Rest

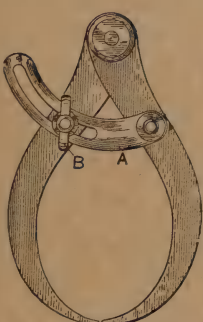


Fig. 42.—Outside Callipers, with Quadrant Arm

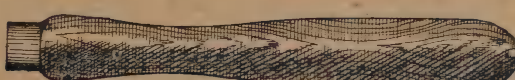


Fig. 44.—Tool Handle of Approved Shape

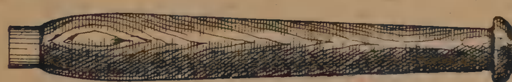


Fig. 45.—Tool Handle with Button End

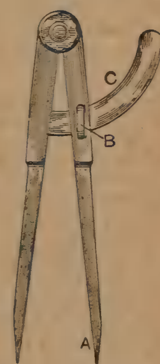


Fig. 43.—Compasses or Dividers, with Quadrant Arm

Diamond-point Tools.—The diamond-point tool is shown in front, back, and edge views by Figs. 36 to 38. It is ground to the shape shown in Fig. 37, the bevels being ground off from the centre of the back, as at A B, to form the edges A in the edge view (Fig. 38). The diamond-point does its work by scraping, so it has both edges turned over for that purpose.

Hook Tools.—The hook tool (Figs. 39

and 40) is an adaptation of the wood-turning gouge for hollowing out work which is otherwise too deep and contracted for operating with the ordinary turning gouge. For this reason the cutting point of the hook tool is formed somewhat similar to the turning gouge, with the extreme point curved back as shown at A, to prevent its digging into the bottom of the work. The cutting edge is prolonged towards the shank of the tool, as indicated at B, to afford clearance for operating with the gouge-like point of the tool, and also to permit the prolonged

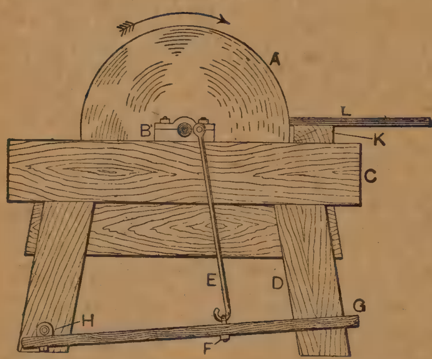


Fig. 46.—Side Elevation of Grindstone

edge towards B being used as an inside chisel for smoothing work (see also p. 336).

The hand rest is forged from square rod-iron, of $\frac{7}{16}$-in. or $\frac{1}{2}$-in. section, with the point turned up to form a crotch as at A (Fig. 41), to afford support to and give efficient control of the tools.

The side tool, diamond-point tool, and hook tool are mostly used in conjunction with the hand-rest, the use of which is explained later in the chapter entitled "Simple Wood-turning."

Completing the Outfit.—The turner's outfit also includes such joinery tools as planes, saws, axe, square, oilstones, callipers (inside and outside), compasses, etc. The callipers being a necessity, and constantly used for adjusting correct diameters, it is most useful to have several pairs of different sizes, as it is often necessary to have two or more set to certain diameters. Fig. 42 shows a useful style of callipers, which can be rigidly set to size by means of the quadrant arm A, which is slotted for adjustment and fixed when set by means of the thumbscrew B.

The compasses are specially used for describing circles on "plank" stuff, and also in accurately marking circular lines on screw-chuck work. The pattern shown by Fig. 43 is useful and strong. The legs A, being set to the desired radius, are held rigid by means of the screw B, which firmly pinches the quadrant arm C.

Tool Handles.—The handles of wood-turning tools are made about 11 in. long and about $1\frac{1}{2}$ in. or so in diameter at the thickest part, so as to form a comfortable grip for the hand; the handles of ordinary woodworking tools do not afford sufficient leverage. In the writer's opinion, handles of the shape shown in Fig. 44 are much preferable to the shape shown in Fig. 45, the buttonlike end of which is apt to catch in the turner's clothes, and thus cause the tool to slip.

Grinding Tools.—The turning chisels when bought are usually right so far as the obliquity of the cutting edge is concerned, and only require the careful and equal grinding of both bevels to an acute edge. However, the turning gouges generally leave the toolmaker's hands with straight, sloping points, which, being too long for the turner's purpose, require to be shaped on the grindstone to the short, rounded form which is the best for use in wood-turning.

The Grindstone. — Regarding the grindstone, a medium hard stone, although it does not cut very quickly, is more durable and better adapted for grinding keen-edged tools. Such a stone of, say, about 2 ft. in diameter and about 4 in. thick is very suitable for the purpose, and can be fitted to drive by foot power on a strong wooden framing made of $6\frac{1}{2}$-in. by $2\frac{1}{2}$-in. white pine batten stuff, as shown in Fig. 46, in which A represents the grindstone running in the bearings B, which are bolted on the top of the stringers C, bolted to the legs D. The grindstone revolves in the direction of the arrow-head towards the workman, and is driven by the connecting rod E, the top end of

which is bored to suit the crank pin keyed on the grindstone spindle. The lower end of the connecting rod is hooked through the eyebolt F, which is fixed with a nut and washer underneath the treadle board G. The treadle board is pivoted by means of an eyebolt and an ordinary bolt fixed into the back leg as indicated at H. The grindstone should be provided with a trough underneath to catch the drippings and grindstone refuse. A water drip-can, with adjusting tap to regulate the water drip on the grindstone, should be erected overhead.

Although experienced hands can grind the tools on a dry grindstone, with a can of water at hand, into which the tool is dipped as it is felt to be getting too hot for safety, yet the beginner would certainly "burn" his tools if he tried to grind them to a thin edge in this manner. The heat resulting from the friction of the stone against the tool is sufficient to destroy the temper of the cutting edges, and care must be taken to avoid this. If during grinding the edge of the tool changes to a blue colour, the coloured portion must be ground away.

Owing to unequal hardness of the grain, the face of the grindstone wears untrue through use, and therefore requires occasional truing up to keep it in good working order. A bar of iron or wood will serve the purpose of a rest if fixed on top of the grindstone frame as indicated at K (Fig. 46), and the face of the stone is turned true with a piece of iron pipe about $\frac{1}{2}$ in. or so in diameter and of convenient length. A similar length of $\frac{3}{8}$-in. iron rod will serve the same purpose; but the pipe is best, and a piece of old cycle tube will do very well.

In truing the stone, the tube or rod is firmly held on the "rest" as shown at L, and at the same time rolled across the face of the stone. The grindstone should never be allowed to become so much out of truth as to require much trouble in truing up, but in the case of one being badly out of truth, the stone should be revolved and a true circle line, as large as the uneven diameter of the stone will stand, marked on the side. The high parts can then be roughly chipped off, and the stone turned true.

Grinding Gouges.—In Fig. 47 A represents an enlarged view of the grindstone face, showing the operation of grinding the tools, which are lettered B, C, D, and E. (This illustration does not necessarily show the relative positions of the tools.) In grinding the gouge, the tool handle is held with the right hand, the left hand being merely held loosely on top of the blade to steady it on the grindstone, and to assist and regulate the angle of grinding, at the

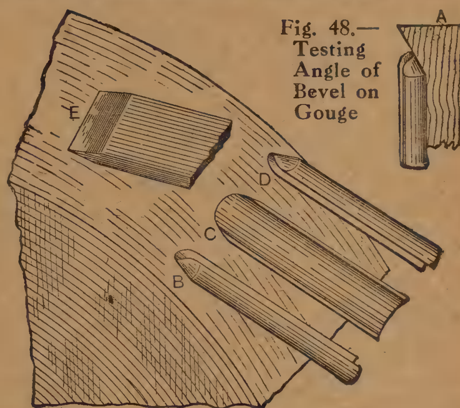


Fig. 48.—Testing Angle of Bevel on Gouge

Fig. 47.—Positions of Gouge and Chisel on Grindstone

same time allowing free play for the right hand rolling the tool to and fro, right or left, as the case may be. As an attempt to show clearly the grinding motion, the gouge is shown partly on its right-hand side at B, while, as at C, the rolling motion in grinding has carried the tool farther across the stone, and shows it lying fairly on its back; and the continuation of the motion brings the grinding round towards the left-hand edge of the tool, as indicated by its altered position at D. The gouge is thus ground by rolling it to and fro with light pressure on the grindstone, also keeping the tool in motion laterally to and fro, so as not to wear the face of the stone into ruts, which would tend to make it awkward for grinding chisels.

As for the angle at which the gouges are ground, wood-turners simply gauge the angle by sight; but the beginner will not

be far wrong in grinding the gouges to an angle of from 20° to 30°. The writer prefers them ground thinner for the sake of the keen, cutting edges that thin tools afford. If there is any difficulty in judging the angle, a gauge can easily be made from a thin slip of wood, and applied to the back of the gouge as shown at A (Fig. 48); but the beginner will soon learn to dispense with gauges.

In grinding gouges that have been sharpened on the oilstone, the sharpening bevel will form a guide to future grindings, the tool being simply ground at a proper angle until the sharpening bevel appears to the eye as the finest possible line equally round the edge. In the case of new tools, the grinding is continued until the edge is just perceptible to the eyes.

Grinding Chisels.—The turning chisels are ground as at E (Fig. 47). They are held with the hands, but there must be no rolling motion of the tool, nor must there be any tendency to rock the tool up and down. This caution also applies to those gouges and other turning tools which, instead of being ground convex, are ground rather concave; the degree of concavity will, of course, depend on

Fig. 49.—Sharpening a Gouge on an Oilstone

the diameter of the grindstone. The radius of a 12-in. diameter stone is much quicker than the radius of a 2-ft. stone, so that with small grindstones the bevel must be ground proportionately shorter than would be the case with the larger grindstone. However, the bevels of the turning chisels may be ground to an approximating angle of 10° to 15°, which, allowing for reasonable concavity of grinding, will give chisels with strong and keen-cutting edges for the beginner. The

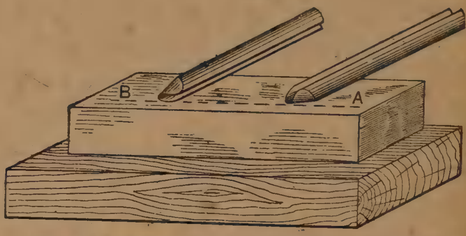


Fig. 50.—Positions of Gouge on Oilstone

grinding should be done equally on both sides of the tool.

Scraping chisels are similarly ground, but with the bevel only on the back of the tool at an angle of about 30°.

Grinding Parting Tool.—The parting tool, especially the one $\frac{1}{16}$ in. thick, being so narrow on the edge, will perhaps be more difficult to grind. The tool must be held, with very light pressure, at right angles to the grindstone without wobbling, the bevels being equally ground on both edges to the point of angle of about 30°, so that the point is ground square across with sharply defined corners. Good parting tools may be made from old flat files of suitable width and thickness. The files may be softened by heating to a red heat, and then slowly cooling in ashes, after which the file teeth can be ground off, the point fashioned on the grindstone, and the tool afterwards hardened by making it red hot and quenching in water. The hardened tool is then tempered by first brightening it on the grindstone, and then laying it flat on a thick bar of red-hot iron, when the heat will be noted to penetrate the tool, changing the brightened surface first from a pale straw colour, which as the heat increases changes to brownish straw colour, at which hue the tool is instantly quenched by dropping it point downwards into a bucket of water. Although it takes a little more work to grind off the file teeth, the tool may also

be made without the previous softening by simply grinding off the teeth and fashioning the point as before, and then tempering the tool by drawing down the temper (which is still of file hardness) as before to a brownish straw colour. The beginner should understand the reason for drawing down the temper is that "file temper" is so hard and brittle, that the parting tool, if used without altering the temper, would be apt to break without warning.

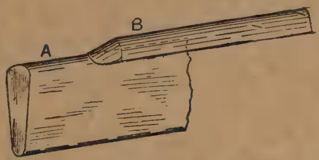


Fig. 51.—Position of Gouge on Slip

Oilstones.—Regarding the oilstones and slips for sharpening the tools, the writer prefers Arkansas and Charnley Forest stones as giving good wear and keen edges to the tools. In choosing a Charnley Forest stone, it is advisable to reject such as show white blemishes, as these indicate hard, knot-like parts, which make such stones wear unequally. The stone should be of equal grain and colour all over, and not too soft. Trying it with the point of the thumb nail when purchasing is a good plan for testing the abrading quality of the stone, which is of importance. One oilstone could be made to serve for gouges and chisels, but it is best to have two stones, because the gouge wears a stone into ruts in sharpening, and it is best to have it so, for the reason that the gouges are thus quicker and easier sharpened in the ruts than on a perfectly flat stone. However, one of the broad sides of the oilstone should be used for sharpening the gouges, and the beginner should acquire the habit of sharpening the smaller-size gouges towards the right- or left-hand side of the stone, reserving the other side for the larger gouges, so that one broad face of the oilstone becomes worn into two or more ruts, lengthwise of the stone, as will suit the curves of various-size gouges. Of course, when the ruts become worn inconveniently deep, the stone can be turned upside down, and used on the reverse side. When too badly worn for gouge sharpening, a good stone should not be thrown away ; but it can be split with a thin-ground cold chisel, and the pieces shaped with the grindstone into slips suitable for sharpening turning gouges and carving tools.

Sharpening Gouges.—In grinding the gouges, the arc of grinding will leave the bevel slightly concave, so that in the first sharpening on the oilstone the bevel of the tool is rubbed perfectly flat, the heel and point equally touching the stone whilst sharpening, and this position should suffice for several sharpenings. As the tools become thicker with frequent sharpening, the heel of the bevel may be raised a little by holding the tool handle a trifle higher, and the tool thus sharpened at a slightly more obtuse angle to save labour in having too much metal to rub away. However, this should not be carried to excess, because obtusely sharpened turning tools do not work very well, besides being awkward to use. Indeed, when the tools become so thick as to require obtuse honing, it is more advisable to re-grind them.

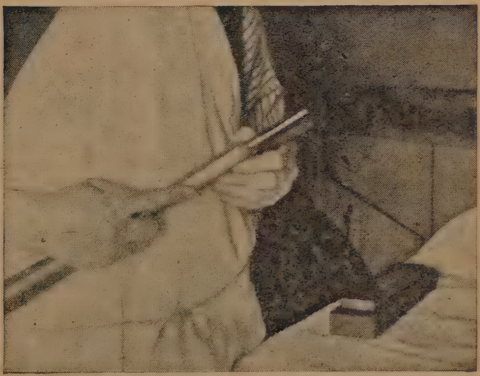


Fig. 52.—Sharpening Gouge on Slip

For the work of sharpening gouges, the operator should stand in front of the oilstone, which should be handily placed on the lathe bed. The tool is held much

the same as for grinding, but with the handle raised to suit the angle of bevel, and in this position the tool is rubbed longitudinally on the oilstone to and fro with somewhat quick motion and light

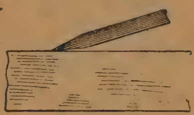


Fig. 53

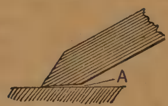


Fig. 54

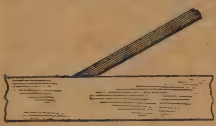


Fig. 55

Figs. 53 to 55.—Positions of Chisel, Parting Tool, and Scraper, respectively, on Oilstone

pressure (see Fig. 49). At the same time the gouge bevel is rolled from edge to edge on the stone, until the grinding edge becomes invisible and a slight roughness, which is termed the wire edge, may be felt turned over to the hollowed side of the gouge. The slip stone is then used on the hollow of the gouge to turn back the wire edge, and thereby assist in working off the roughness, which is finally removed by alternately rubbing the gouge on the oilstone and slip. The gouge motion in sharpening should follow the direction of the dotted line A B (Fig. 50), and in using the slip, which is held in the left hand (see Fig. 51), the gouge is rubbed to and fro on it with the right hand; in Fig. 51 A represents the slip stone and B the gouge. In using the slip, the tool must not be angled up so as to rub off the wire edge, but must be rubbed quite level along the slip, rolling it from edge to edge. Fig. 52 shows the correct method of manipulating the slip stone and gouge in working off the wire edge.

Sharpening Chisels.—The sharpening of the turning chisels is comparatively easy. The chisel bevels are held flat on the oilstone, rubbing lightly to and fro longitudinally on the stone, equally and alternately, a few rubs at a time, on both bevels until the wire edge disappears; or if sharpening an ordinary blunt tool (in which case there is no need for rubbing to the extent of forming a wire edge on the tool), until the blunted edge becomes invisible. When the tool edge becomes rather thick, the heel of the bevel may be raised a trifle, as shown in Fig. 53, to save too much rubbing on the oilstone. But the beginner must avoid any tendency to rock the tool up and down, this being apt to round the sharpening facets and form awkward cutting edges.

Sharpening Parting Tool.—The parting tool is sharpened on the oilstone as indicated at A (Fig. 54), rubbing it on the stone as for the turning chisels alternately on both levels. Hold the tool fairly and squarely on the edge at right angles to the stone, without any rocking or rolling during the sharpening operation, so as to ensure the cutting edge being straight across on the point and sharp-cornered.

Sharpening Scrapers.—The scraping chisels being ground with the single bevel on the back of the tool, are sharpened as shown in Fig. 55. The edge in this case is entirely rubbed up from the back bevel, the tool needing only a few light rubs on its flat face to remove any wire edge. To some extent the heel of the bevel may be raised to assist the sharpening of thickish tools; but the flat

Fig. 56.—Method of Turning over Edge of Scraper

face of such tools is held quite flat on the oilstone. After being sharpened on the oilstone, the scrapers should have the edge turned over to form the scraping edge, and this is done with the smooth

back of the turning gouge, a $\frac{3}{8}$-in. gouge being the most handy size for the purpose. In turning over the edge, the chisel is held in the left hand, the right hand grasping the blade of the gouge, with the thumb pressing against the near edge of the chisel. Then, pressing the gouge moderately firm on the back of the chisel, the edge is turned over by a motion of the right wrist, sliding the gouge across the back edge of the chisel, and at the same time sliding it in a slanting direction upwards, so as to avoid danger of breaking or blunting the turned-over edge. The steel or gouge used for turning over the edge must be perfectly smooth, therefore any spottiness, which indicates rust, must be rubbed off smoothly on the oilstone, otherwise a rough edge will be the result. There is a good deal of knack, only acquirable through experience, in turning over the scraping edge. The angle at which the gouge is held in turning over the edge is approximately 45° ; but this is not arbitrary, because the angle will vary as to tools newly ground and sharpened and tools that have had several sharpenings. In the latter case the edge would be turned over at a more obtuse angle, according to the thickness of the edge.

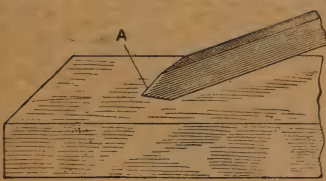


Fig. 57.—Diamond-point Tool on Oilstone

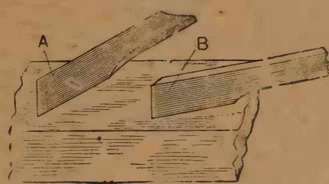


Fig. 58.—Side Tool on Oilstone

Fig. 63

Fig. 64

Fig 59

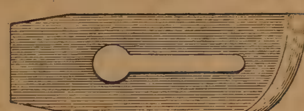


Fig. 61

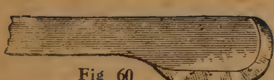


Fig 60

Fig. 62

Fig. 65

Figs. 59 to 65.—Various Scraping Tools

Fig. 56 shows the correct position of the hands in holding the gouge and scraper in turning over the edge. The scraper in this case is an ordinary plane-iron, which, being ground and sharpened as detailed for the scraping chisel, makes a most useful scraping tool. The manipulation in turning over the edge is similar to that required for the chisel.

SHARPENING AND GRINDING SPECIAL TOOLS AND BORING-BITS

Sharpening Diamond-point Tools.—The diamond-point tool is used principally for turning beadings on the end grain of wood, and also to a limited extent on side wood, such as circular mouldings and similar work which is chucked on the screw-chuck. Fig. 57 shows the sharpening of the diamond-point on the oilstone, the tool being, as shown at A, rubbed equally on the stone on both bevels to a sharp edge, and also lightly on the face, which must be held quite flat on the stone to remove any wire edge. The edges thus sharpened are then turned over to form the scraping edge, and in doing so the beginner must take special care not to injure the needle-point of the tool.

Sharpening Side Tools, etc.—The side tool is chiefly used for hollowed-out work, such as finishing the insides and bottoms of turned boxes, etc. Fig. 58 shows the method of sharpening the side

tool, it being held and rubbed on the oil-stone as at A in sharpening the point, and on the side bevel as at B in setting up the side edge. The tool is also lightly rubbed

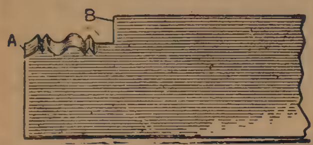


Fig. 66

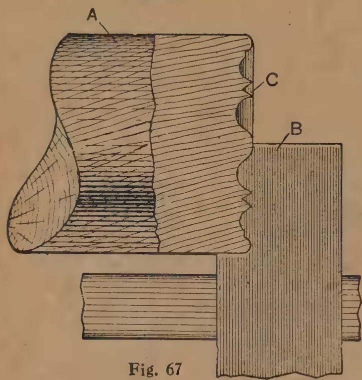


Fig. 67

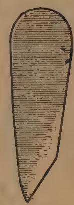


Fig. 68.—Slip for Sharpening Patera Cutters

Figs. 66 and 67.—Patera Cutter and Method of Using It

flat on the face in working off the wire edge, and the sharpened edge is turned over to a scraping edge. The side tool when worn down should not be discarded, but ground to a tapering point as shown at A (Fig. 59).

Fig. 60 gives the back view of a round-nose side tool, showing how the bevel is ground, while Figs. 61 and 62 give back and edge views of a plane-iron scraper, showing how to grind these tools for special jobs, the one shown in Fig. 61 being suitable for finishing flat hollowed work. Figs. 63 to 65 give back views of typical cranked tools of the scraping order.

Patera Cutters.—Fig. 66 gives the back view of a tool for turning the complete design at one operation. This tool is home-made from worn-out flat files, and is very useful for turning pateras quickly and uniformly to size and pattern. The cutters are, of course, varied in size and style of beading to suit the design of pateras.

In making these patera cutters they should not be tempered too hard, as owing to the intricate forms of cutting edges they are not handily ground. The bevels for the most part require to be filed to shape, an angle of about 50° being acute enough, and gives a good, strong wearing edge for this kind of tool. In tempering they may be drawn down to a somewhat bluish colour, so that they can be shaped with the file. It will be understood that the cutting edge from A to B (Fig. 66) is one-half the diameter of the patera, the projecting shoulder B forming the "stop-guard" which bears against the cylindrical edge of the revolving wood whilst turning the patera, which is, of course, turned facsimile in reverse of the cutter, as shown in Fig. 67. This illustration gives a plan view of the turning operation, showing the cylindrical rod A partly in section. The patera being gauged to thickness, is afterwards cut off with the parting tool. The patera cutters are sharpened with an oilstone slip, shaped as shown by Fig. 68, at the angle of the bevel; but although such tools work better with the turned-over edge, the irregular outline of the edge usually precludes turning it over.

Sharpening Nose-bits.—The wood-turner's kit includes boring-bits of various sorts, such as nose-bits, spoon-bits, centre-bits, and twist drills, etc., and they are constantly in use either in self-centering chucks or, more commonly, in hardwood

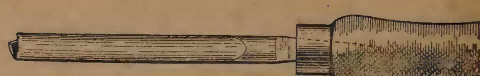


Fig. 69.—Nose-bit in Handle

Fig. 70.—Boring Tool Adapted from Old Nose-bit

Fig. 71.—Spoon-bit

stoppers driven firmly into the ordinary cup-chuck. The bits are also much used for lathe work, knocked temporarily into ordinary turning-tool handles as shown

in Fig. 69, the same handle often being used for a number of different bits. The one shown by Fig. 69 is termed a nose-bit, and it is so called on account of its

Fig. 72.—Centre-bit


Fig. 73.—Plug Centre-bit


Fig. 74.—Taper-bit

peculiar-shape nose which is well adapted for withdrawing the "core" of borings, and is therefore much used by turners, especially for end-wood boring. Like the other wood-turning tools, boring-bits also require to be kept well sharpened to work properly.

The nose-bit is sharpened with a triangular file, a small one with the file teeth cut to the point being most suitable; and in sharpening the bevel is filed from the inside of the nose. A few light strokes of the file should suffice for sharpening; and the filing should cease whenever the wire edge appears, which is unmistakably known by the gripping feel of the edge with the finger.

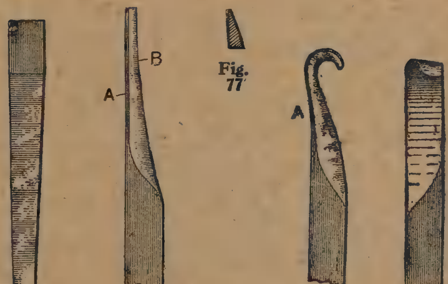
If a nose-bit gets broken it should be ground square across the point at an angle of about 80°, as indicated at A (Fig. 70), when it will still be found a capital boring-bit for either end or side wood. Indeed, it will thus bore much more quickly than with the original nose; but it is not quite so good for withdrawing the borings.

Sharpening Spoon-bits. — Fig. 71 shows the spoon-bit, so named on account of its spoon-like point. It is sharpened by filing up the edge from the inside of the flute; but the point and along the flute may be further sharpened with the oil-stone slip, which gives a keener cutting edge for clean and smooth boring.

Sharpening Centre-bits.—The ordinary type of centre-bit is shown by Fig. 72; it is exclusively used for boring side wood. The point of the bit is usually made tapering, triangularly to form three cutting edges, and thereby reduce the labour in using such bits with the hand-brace. But for the wood-turner's purpose, and especially for boring through-going holes, which, to prevent splintering the through-going edges, are bored from both sides of the wood, the triangular points are best filed off to a smooth, round, tapering point; and the sharpening of the bit is effected by whetting both the vertical cutter and the radial cutter, A and B, to a sharp-cutting edge with the oilstone slip, and judiciously thinning the cutters with the file as they become too thick for easy honing.

Fig. 73 shows an adaptation of the centre-bit, and is termed a plug centre-bit. This is most useful, the plug point enabling it to bore true holes by guidance of the screw-hole in the screw-chuck work, and also for many other jobs. The sharpening is the same as for the ordinary centre-bit, that is, on the inside of the cutters, the plug point being left untouched.

Other Boring-bits. — The taper-bit



Figs. 75 to 79.—Various Stages in Making Hook Tool from Square File or Rod

(Fig. 74) is used for reaming out tapered holes in wood, and it is sharpened from the inside of the flute similar to the spoon-bit. There are of course, many other

varieties of boring-bits and boring-bars which are frequently used ; but different sizes of those mentioned will provide for most purposes.

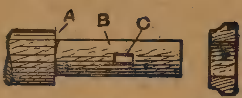


Fig. 81 Fig. 82

Figs. 81 and 82.—Hardwood Spindle, with Collar, for Emery-wheel

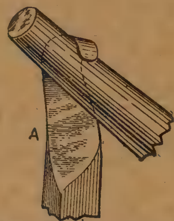


Fig. 84.—Sharpening Hook Tool

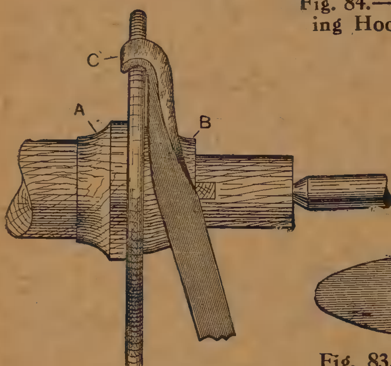


Fig. 80.—Method of Grinding Hook Tool

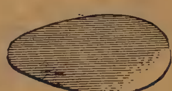


Fig. 83. — End View of Setstone for Hook Tools

Making Hook Tools.—The hook tool is an adaptation of the turning gouge and is particularly well adapted for turning the inside of hollow work which is otherwise too deep and narrow to be treated with the ordinary turning gouges. The hook tool is often made by turners themselves, mostly from old files of square section ; but tool-steel rod is, of course, better, since it needs no elaborate finishing. The hook tool shank is forged about $\frac{1}{2}$ in. square, with the end fashioned into a thick tapered tang, which is driven into a stout handle $1\frac{1}{2}$ in. in diameter and about 1 ft. 3 in. long. The tool has often to stand heavy strains in using, so for this reason the handle should be fitted with a strong ferrule. The forging of the hook is simple. The file (if such is used for making the tool) is made red-hot all over, and the file teeth planished fairly smooth and the tang fashioned as in Fig. 75. The other end is then re-heated and forged as in Fig. 76, the bevelling for the hook being as shown by Fig. 77, which is a section across A B (Fig. 76). The point is then bent with the hammer round the beak of a small anvil (a small bolt fixed horizontally in the bench vice makes a good substitute) to form the hook, and at the same time is given a lateral set to the left as indicated by the slight curve at A in Fig. 78. A suitable length for the hook tool would be about 1 ft. 3 in., with the hook of about $\frac{3}{8}$-in diameter curve, and the extreme point re-curved and rounded as shown by Fig 79.

The cutting part only needs to he hardened. The point of the tool for about 2 in. or so is heated to cherry-redness, and then hardened by quenching or plunging the hot end into a bucket of water. The hardened point is next brightened on the grindstone so that on re-heating the tool for tempering the colour changes can be seen. The hardened part of the tool is next placed on a thickish bar of red-hot iron and when a brownish-yellow colour appears the tool is immediately lifted off the hot iron and allowed to cool. This treatment gives a good wearing edge.

Fig. 85.—Method of Sharpening Hook Tool

Grinding Hook Tools.—The grinding of the hook tool is rather difficult to the beginner, because the inside of the hook cannot be ground on the ordinary

stone. Failing a special grinding appliance, the simple and inexpensive method shown by Fig. 80 can conveniently be adopted for the purpose; it will also be found useful for grinding such tools as patera cutters, etc. The makeshift grinder is simply a $\frac{3}{16}$-in. or $\frac{1}{4}$-in. emery-wheel mounted on a hardwood spindle running between the lathe prong and poppet centres. The wooden spindle is turned with a shoulder as at A (Fig. 81), the parallel part B being turned the size to suit the hole in the emery-wheel. The wheel is held firm and true between wooden collars, which are bored to suit the spindle (as shown in section in Fig. 82), and which, abutting against the shoulder A (Fig. 81), are fixed with a wooden key driven through the slot C. The appliance is shown with two collars A and B (Fig. 80); but if the spindle is turned from a piece of wood thick enough, one collar only on the keying side will be necessary. The grinding of the inside of the hook is done by working the tool to and fro round the periphery of the emery-wheel as indicated at C (Fig. 80). The back of the hook tool can be ground on the ordinary grindstone, grinding smoothly round the outside of the hook from the shank to the recurved point.

Sharpening Hook Tools.—The setstone for sharpening the hook tool is prepared from a piece of ragstone, which may be obtained for a few pence from an ironmonger. The ragstone is generally in rough, splintery pieces, and a piece about 7 in. or 8 in. long should be selected, and fashioned to shape for using. This is easily managed by grinding the splinter on the flat side of the grindstone to a somewhat oval section, as shown in the end view (Fig. 83). Water is the lubricant used with the ragstone, and the hook tool is sharpened by rubbing up the edge from A (Fig. 84) to the re-curved point, the stone being rubbed level from the heel to the edge of the tool to avoid rounding the edge, the edge being similarly rubbed up lightly from the outside of the curve. Fig. 85 shows the method of holding the hook tool, the shank being, as shown, in the left hand, with the tool handle under the armpit.

Cements That Withstand Hot Water

CASEIN cement, made by dissolving 4 parts of casein in 1 part of strong ammonia and 10 parts of water, will withstand hot water to a certain extent, as will also a cement made by mixing powdered quicklime with white of egg; but even these are not altogether satisfactory. Magnesia cement, made by mixing magnesia with a solution of magnesium chloride (specific gravity, 1.25) has greater resisting power; it requires a few hours to set, but soon becomes as hard as stone. Silicate of lime, made by mixing chalk or whiting with silicate of soda, sets almost immediately, and often answers quite well.

Another recipe is: Take 1 oz. of best gelatine, add a little water, and allow to stand overnight; then melt down by gentle heat, add $1\frac{1}{2}$ dr. of bichromate of potash, and stir till dissolved. Keep the cement in the dark till required, then melt it, apply it to the broken parts, bind them up, and expose to the light. The gelatine is oxidised by the bichromate after exposure to light, and it then becomes insoluble in water.

A glue or cement that resists hot water, acids and alkalis is made with (*a*) 3 parts of gum shellac dissolved in ether, free from alcohol; and (*b*) 1 part of indiarubber dissolved in the same way as the shellac. The two solutions are mixed together and kept in a sealed bottle for a week or so to mature. By further thinning with ether there is produced an excellent varnish which can be used for such purposes as waterproofing joints and seams in leather goods.

Scene-painting for Amateur Theatricals

THEATRICAL scenery is not intended to be closely scrutinised, but is to be viewed from a distance, and when boldly and broadly treated it will be effective in giving pleasure to the spectators.

The size of a scene will depend on the space available for it on the stage. The wall of a room is the best place against which to fix the scene whilst painting it. The scene should lie flat against the wall, thus occupying little space, and with proper care there need be but little mess. Pieces of calico or paper should be pinned up to protect the wall-paper from splashes of colour, and similar pieces should be placed on the floor to preserve the carpet.

Frame or Stretcher.—A frame or stretcher on which to nail the calico can be made with six deal battens, about 1 in. thick and 4 in. wide. Two battens should be placed in a horizontal position, and fixed to the wall, one near the top and the other near to or on the floor. Two battens are then fixed on them in a vertical position, one at each side. The remaining two battens must be cut so that they cover the two horizontal pieces, and fit between the vertical battens, thus making the frame with a plane surface.

Canvas.—The canvas used in theatres is flax sheeting; but unbleached calico, which can be purchased at any draper's shop, is a cheap and fairly strong substitute. It should be as wide as possible, and carefully sewn together at the edges, until the size of the scene is obtained, taking care that the seams run horizontally across the canvas, which allows it to hang better and also to roll up more evenly. The calico should be strained evenly and carefully on the frame, using for the purpose large tin-tacks, which should be placed as near the edge of the canvas as possible. Begin by stretching along the top, then stretch the bottom and sides, and when the sheet is taut, pass a wet sponge, cloth, or brush over the surface to take out any wrinkles. The tacks should not be driven right in, otherwise the scene might be damaged when removing it from the frame.

Priming.—When the calico is properly strained and dry it must be prepared for painting by coating with distemper priming, which can be made as follows: Put in a pail, 1 part of strong size and add 3 parts of hot water, and stir until the size is melted. Then, in another receptacle, crush and dissolve some whiting in water until the whole is as thick as cream, and then mix with the size and water, stirring well together. This priming should not be made until required for use, as when cold it sets and is unworkable. Apply the priming with a whitewash brush, working from the top downwards, avoiding as much as possible going over the same place twice, and be careful to leave no part of the calico untouched, otherwise it will cause trouble when the scene is being painted. When quite dry there should be a white, even surface on which

to work. Priming may be of any colour, according to the style of work contemplated; many artists have their canvases laid in a "smudge" colour, which is a mixture of all the odds and ends of waste colour. Of course, in the case of skies or other light subjects, white is best.

Tools, etc.—The brushes for scene-painting are such as are used for oil painting—hog-hair, flat and round in various sizes, and a few ordinary round and flat sash brushes. A straightedge about $\frac{3}{4}$ in. thick, 3 in. wide, and 3 ft. long, will also be required.

A method of making a straight line right across the scene is to fix a piece of string (which has previously been well rubbed with charcoal or blacklead) across the frame by means of small nails, lifting it away from the canvas, and letting go suddenly.

For making circles and curves, a pair of chalk compasses (Fig. 1) should be used. These can be purchased or can be made by joining together two pieces of wood, about 15 in. long, with a small thumbscrew, which, by screwing, fixes the instrument as required. A nail is inserted at one end, and at the other a porte-crayon, or chalk-holder, in which can be placed a piece of charcoal, chalk, or pencil.

A wooden set-square is cheaply bought, or a substitute can be made from stout cardboard about 7 in. wide and 7 in. high.

Palette.—The scene-painter's palette is a square, flat board; about 2 ft. long, 18 in. wide, and 1 in. thick is a convenient size. The nests for the colours are placed upon it (see Fig. 2). The board is

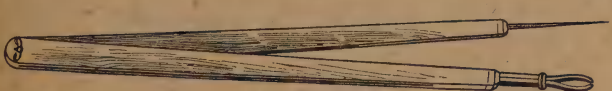


Fig. 1.—Chalk Compasses

used in mixing the tints, and if only a small portion of the scene is painted at a time the colour may be taken on a brush, worked up with the medium, and used at once.

Where a large surface is to be painted, it is best to mix sufficient colour in a jar or basin, keeping it warm and liquid near a fire, and taking care not to let it simmer or boil. The medium for the colours is the same as for priming, a piece of wood being useful for mixing.

Fig. 2.—Scene-painter's Palette

A basin of warm water to cleanse any brush of the colour will be found useful. Care should be taken to work as cleanly as possible, and not to prepare more colour than is required at one painting, as it soon sets and becomes very hard when cold owing to the binding nature of the size with which it is mixed. To bring it up with fresh colour is sometimes impossible, and certainly never advisable. Whiting, size, and water, prepared as for priming but made thicker by adding more whiting, should always be at hand to mix with those colours which require to be of a lighter tint.

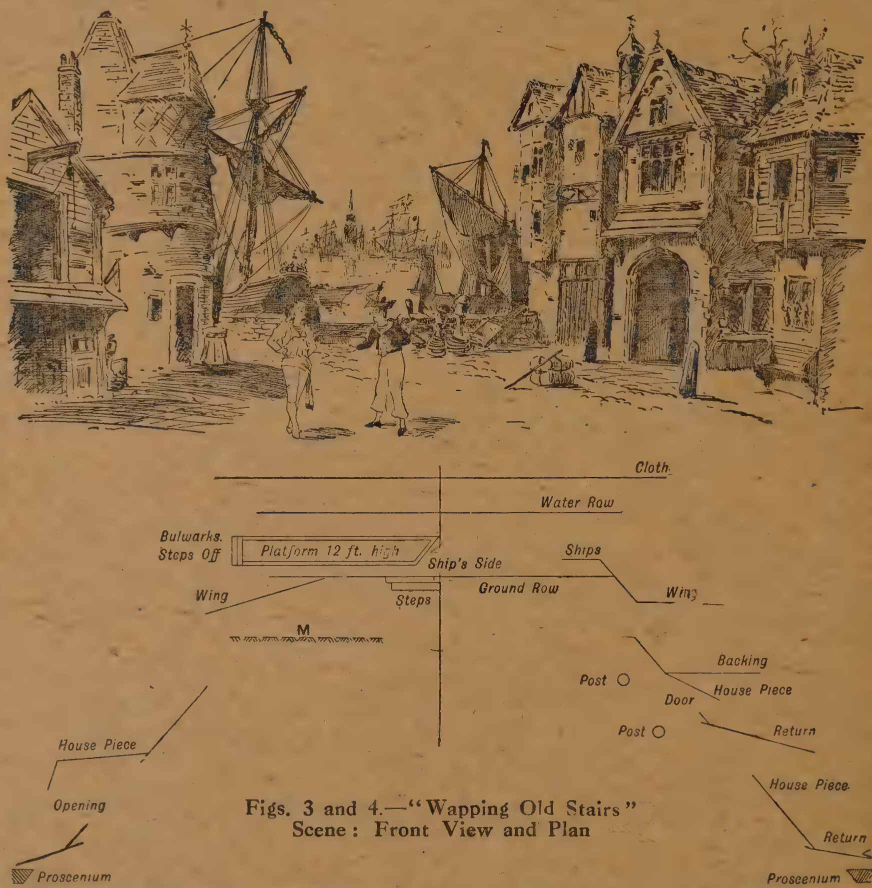
It is advisable not to have too many colours on the palette, as with judicious blending sufficient tints can be obtained.

Colours or Pigments.—Colours in powder, obtainable from most oilshops, will be found to work well for all requirements. The following is a list of the colours that will be suitable: Lemon chrome, orange chrome, coral red, cobalt, burnt umber, paris black, vandyke brown, red-lead, brunswick green, chrome green, emerald green, and burnt sienna.

Preliminary Sketch.—Trouble and time may be saved if, when the scene is decided on, a small rough sketch is made in colour, the object of this being that, having a coloured subject from which to

work, there need be no hesitation when dealing with a big surface.

Enlarging the Design by "Squares" Method.—Before painting, the design selected should be divided into squares, and all the lines numbered. Then the canvas should be divided up in the same way, but on the large scale, of course, and painting each colour dries very much lighter than when first put on (from ten to twenty shades), so that what would look effective and artistic while wet would appear very washy and flat when dry. Therefore, before beginning to lay on the colours the effect to be produced must be well considered or tried experi-



Figs. 3 and 4.—"Wapping Old Stairs" Scene: Front View and Plan

the lines numbered to correspond with those on the design.

Having prepared the design and canvas in this way, it is a simple and easy process to make a drawing on the large scale from the design, copying it into corresponding squares on the canvas.

Testing Shade of Distemper.—It should be remembered that in distemper mentally on a small scale. The most convenient material on which to test this is pipeclay, which, being very absorbent, allows the distemper colour to dry almost immediately. By this method very little time is lost. Instead of the pipeclay a piece of calico, ready primed as for the scene, will answer equally well. This should be held near the fire to dry quickly.

Painting "Wapping Old Stairs" Scene.—It is supposed that a scene representing Wapping Old Stairs (Fig. 3) is to be painted. Fig. 4 represents the ground plan. It is always advisable to

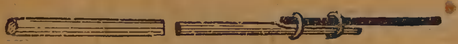


Fig. 5.—Charcoal Holder

begin on the distance, and work down to the front of the scene, the colours gaining in strength as advancement is made; therefore begin on the back cloth. Say that the cloth is to be 30 ft. wide by 21 ft. high, and the design 15 in. wide by $10\frac{1}{2}$ in. high, ruled off into inch squares. The cloth proper should be divided into 2-ft. squares, which can be done by means of the chalk line.

Then with two rubber rings fix a piece of charcoal on the end of a stick about 4 ft. long (see Fig. 5), and proceed to draw out the subject in outline, going over the charcoal marks with a dark colour mixed with half-and-half size. This will show faintly through the colours laid on it, and enable the original drawing to be followed, and the half-and-half size prevents it "rubbing up." Now lay in the sky. When extensive surfaces are required to be of a uniform tint, it is necessary to mix that tint in large quantities. For this scene three pots of sky colour will be needed—a deep tint, a middle and a light; it is also as well to mix pots of cloud colour (light and shadow). Of course, in the case of elaborate skies, the palette will have to be resorted to as well. The colours will be mixed with "working size"—that is, 5 parts of water to 1 part of size.

Begin at the top of the cloth, and to a depth of about 3 ft. lay the canvas in with a deep tint, then the next 2 ft. 6 in. with the middle, and finish with the light tint. These must be carefully blended together, so that no evidences remain of their juncture. The beginner will find this somewhat difficult at first. The clouds are painted in the spaces left untouched by the sky colour, and blended into the same where necessary. The distance is then painted in (now working from the palette), then the middle distance, then the foreground.

A Kitchen Scene.—A design for a kitchen scene is shown by Fig. 6. The stairs and handrail should be done in dark brown, to suggest old oak stained, and the walls in a yellow tone, varied by patches of light grey. The ceiling should be of a dingy white, with old oak beams. The plates at the side of the fireplace represent china plates, those on the mantelshelf being painted a dull grey, touched up with white to represent pewter plates. The grandfather clock should be in mahogany colour, and the fire can be painted

Fig. 7.—Wing

Fig. 6.—Kitchen Scene

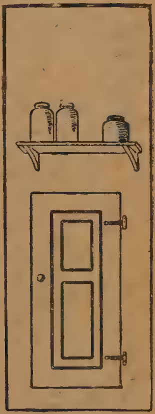


Fig. 8.—Wing

either as if burning or out. First paint the ceiling and the walls, then the oak beams against the ceiling, the stairs, handrail, door, window, and fireplace, and, when the whole is dry, the clock, be deeper in tone, using dark greys and browns. For the foreground stonework use greys, blues, and yellows well blended together, with a touch of light green in places to suggest dampness.

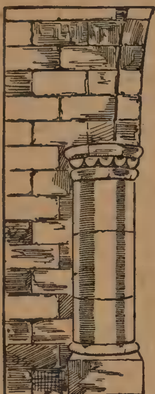


Fig. 10.—Wing

Fig. 9.—Dungeon Scene

Fig. 11.—Wing

plates, etc. Figs. 7 and 8 are the wings. The cupboard door is effective if painted in a light green tint, and the plates in the rack should be done in blue and white.

A Dungeon Scene.—A scene which occurs in many plays where gloomy An excellent plan when painting a scene of this description is, after drawing the design on the canvas, to use a large brush, thus blending the tints in a broad and free manner, and afterwards to draw in the various lines to give the shape of

Fig. 13.—Wing

Fig. 12.—Log Cabin Scene

Fig. 14.—Wing

dungeons, prison cells, or mysterious subterranean passages are required, is shown by Fig. 9. The background should be of a bluish-grey if daylight is supposed to enter at some part, and if the time is supposed to be night the distances must the masonry, first in dark brown, and then with a light stone colour to give the lights on the edges of the stonework. The floor should have the appearance of being covered with straw or of consisting of earth. The cell door should be darker

than the walls. Figs. 10 and 11 are the wings.

Log Hut Scene.—A scene representing the interior of a log hut, or cabin, is illustrated by Fig. 12. It can be made to

Fig. 15.—Sea Scene

appear most realistic if painted in a bold and broad manner, the colour principally used being browns, and, where the high lights occur, greys and yellows. First draw in the scene with charcoal or black paint, and paint the whole with light brown tints. When dry, line out the logs with a dark brown colour, verging to black in places, and then touch up one side of the logs where the light is supposed to strike them with greys, dark greens and yellows. Figs. 13 and 14 are the wings. The cloak hanging on the nail (see Fig. 14) should be either blue or green in colour to present a contrast with the general tone of the scene.

If a view through the window is desired, a small piece of cloth should be painted and hung up behind away from the window, to allow of persons passing between it and the scene.

Sea-piece.—Fig. 15 is a design for a scene which can be used either as a sea-piece entire, or with a set-piece in front when the clouds only are shown. The colour of the scene will depend on requirements. The sea may be a bright blue, green, or grey, and the sky corresponding as rosy and sunny, blue with white clouds, and grey with clouds to match. The sea should be drawn or painted as if without much movement, as shown; it is then not so monotonous for the audience as when done in a turbulent style. The method of painting this scene and the following set-pieces is the same as for the previous scenes.

Set-piece.—The use of a sea-piece scene will be well understood by referring to the set-piece (Fig. 16), which, if placed in front of Fig. 15, forms a scene adapted to historical plays. This scene can be altered by using the foot- or set-piece (Figs. 17 and 18), thus making it a seashore scene; or by using the set-piece (Fig. 19), thus making it a rural landscape. Foliage wings would then complete the picture.

Mounting Scenes on Frames, etc.—As each scene is painted it should be fastened to a roller or stretched on a frame. The latter is necessary when the windows and doors are made to open (see Fig. 20, which is the back view of a scene, and explains the woodwork of battens $2\frac{1}{2}$ in. to 3 in. wide, nailed or screwed together to the requisite size). At the left of Fig. 20 is a door which opens; a window is in the centre, and another is on the right to represent a first-floor window, underneath which is placed a pair of steps to allow the performer to ascend to it. This scene should be supported at the top in grooves, and to steady it when opening and shutting

Fig. 16.—Battlement Scene

the door and window iron stays are attached and fixed to the stage as shown.

Side wings can be wound upon rollers if space is of consequence; if not, they should be stretched upon a frame. The sides of most wings should be kept as straight as possible, but in some cases, for

picturesque effect and other reasons, it may be necessary, especially in the case of tree wings, to bring the foliage beyond the perpendicular of the wing. For this purpose a piece of stout strawboard or cardboard should be cut into the required shape and tacked to the wings. For the projection of a piece of moulding or architecture, the batten can be cut into shape with a keyhole saw.

Fig. 17.—Back View of Set-piece (Fig 18)

Fig. 18.—Set-piece of Seashore Scene

The foot- or set-pieces should be dealt with in the same way (see Fig. 17, which is a back view of Fig. 18). The dark portion of this frame, representing the cardboard shape of the boat, etc., is nailed on to the framework. The oar, which, seen from the front, appears to be resting against the boat, if fixed permanently to the set-piece would be liable to get damaged; it is, therefore, made from stout cardboard, and then slipped in canvas sockets (see Fig. 17).

The foot-pieces are supported by iron brackets as shown in Fig. 20, of which Fig. 21 is a detailed sketch. The iron rod A, with its upper end hook-shaped, is placed in a screw-eye B fixed into the framework of the screen. The lower end of the rod is shaped into a flat ring through which another screw-eye O is screwed into the stage.

Fig. 19.—Set-piece for Rural Landscape Scene

Landscape Scene.—Fig. 22 is a design for a landscape scene, which should first be carefully drawn in with charcoal. Then paint in the sky, and then the extreme background, which should be principally in blues and greys, so as to convey to the eye the effect of atmospheric distance. After this, do the middle distance, the green and other tints of which must have a fair amount of grey, and finish with the foreground in natural colours, as seen from a few yards' distance. When the whole is dry, the buildings, trees, river, bridge, etc., can be painted in. Remember that objects on the landscape, such as houses, trees, etc., will alter in tone according to their position. For example, a red-tiled roof in the middle distance should assume a red purple tone, as a contrast against a decided red roof in the foreground. Figs. 23 and 24 are the wings for the above scene, and both of them should be painted as foreground subjects.

This scene can be made to answer the purpose of two scenes. First, if both the tree wings are used and the left-hand one (Fig. 23) is well pushed on, so as to cover the bridge, windmill, etc., it will do for a wood or forest scene. If the left wing is kept well back and a cottage wing used on the right side, it will make an effective country scene. The left and right are to be taken as seen by the reader.

Cave Scene.—A design representing the interior of a cave is shown by Fig. 25. The rocks must be fairly dark except where the light strikes on them; the sea and sky in their painting and colours will depend on the time, whether day or night. Figs. 26 and 27 are the wings. The colours for the above scene should be dark browns, deep dull reds, with touches

of green where the water is supposed to come. For the lights, greys and yellows should be used.

Paint in the sky first, then the sea and the sanded floor of the cave. Next the

Fig. 20.—Rear View, Showing How Scene is Fixed to the Floor

Fig. 21.—Iron Bracket and Eyes for Screwing Scene to Floor

rocks, and, when these are dry, the crevices and shadows of rocks, using dark brown, here and there verging into black shadow. The patches of shingle on the floor should be done in purples, blues,

Fig. 23.—Wing

Fig. 22.—Landscape Scene

Fig. 24.—Wing

reds, and whites. Two or three small barrels touched up with distemper colour, and bits of old rope, canvas, bits of spar, broken pieces of wood, etc., will add to the artistic and natural effect of this scene.

A House Wing.—Figs. 28 and 29 are the back and front views of a wing that will be suitable for many scenes, but more particularly the one shown by Fig. 3, p. 340.

Victorian Sitting-room Scene.—An interior scene that will serve for the early Victorian or Charles Dickens periods is shown by Fig. 30. The walls should be tinted in a light pink or pale green colour, the moulding to be in white, the fireplace to imitate white marble, and the frame of the mirror above in gold. The curtains at the window should be painted in various colours of a flowered pattern to imitate chintz, the panelling near the window in white, or to match the walls, the carpet to be a bright-flowered pattern, and the picture frames in gold.

In painting this scene, the ceiling, moulding, walls, and carpet can be done in one operation, and when they are dry the fireplace, pictures, curtains, and other objects can be shown. Figs. 31 and 32 are the wings. The bookcase should be coloured in imitation of mahogany or rosewood; while the side table should be painted to resemble gold, with a marble top.


Fig. 26.—Wing


Fig. 25.—Cave Scene


Fig. 27.—Wing


Figs. 28 and 29.—Back and Front of Old-time House

Cottage Interior Scene.—Fig. 33 is a scene of the interior of a rustic cottage. The plaster walls should be white—not a pure flat tint, but white broken in tone with greys, yellows, and reds; and the woodwork light brown and greys. If desired, a landscape may be shown through the windows, in which case the landscape should be painted first and, when dry, the diamond leaded sash. The curtain border above the window should be red, and a good effect is obtained by using real lace or chintz curtains tacked to the scene against the window. The door and windows can be made to open and shut.

The plaster wall and the fireplace should first be painted in, and, when these are dry, put in the woodwork, and the landscape seen through the window. Then show the pictures on the wall, the leaded sashwork at the window, and the objects on the fireplace. Figs. 34 and 35 show the wings, and these should match the scene both in colour and tone.

Garden Scene.—A design for a garden scene suitable for many periods, including even scenes of the present day, is shown by Fig. 36. Its colour may be to individual taste or the requirements of the occasion. As a spring scene it should have a bright and fresh-coloured grass, a yellow sanded path broken up in places with grey- and purple-tinted pebbles, and a bright but pale blue sky, which should be lighter in tone towards the horizon. As a summer scene it would require more purple tints in the foliage, and a more brilliant hue in the blossom of the flowers. For autumn it should be painted


Fig. 31.—Wing


Fig. 30.—Victorian Sitting Room


Fig. 32.—Wing


Fig. 34.—Wing


Fig. 33.—Cottage Interior Scene


Fig. 35.—Wing


Fig. 37.—Wing


Fig. 36.—Garden Scene


Fig. 38.—Wing

with rich brown yellow and golden tints, the sky then being of a deeper blue, flecked with rosy-tipped clouds.

First paint in the sky and the extreme distance. Then show the grass plots and

Fig. 40.—Wing

Fig. 39.—Riverside Scene

Fig. 41.—Wing

pathways, and, when these are dry, the archway and wall, which is covered with vegetation. Then the fountain and middle distance objects, finishing with the foreground objects, such as the plants,

Fig. 43.—Wing

Fig. 42.—River Scene

Fig. 44.—Wing

pebbles on the pathway, etc. Designs for the right and left wings for this scene are shown by Figs. 37 and 38.

Riverside Scene.—Fig. 39 gives a design for a riverside scene, which may be treated either as day or night. The water should be of a dull, dirty sage green, the shore muddy grey, the tiled roof of the inn and the wharf being red. The walls of the inn should represent whitewashed plaster fitted in with oak beams brown in tone. The buildings and the bridge in the background should be painted in blue or grey, so as to give apparent distance. The sky, clouds, water, and muddy shore should first be laid in, and then the bridge and distant houses, allowing each separate painting to dry, finishing with the buildings in the foreground. The wing shown by Fig. 40 should be painted dark with red tiles. The right-hand wing (Fig. 41) has a dirty

plaster wall at the top, and the lower brickwork should be in yellows and reds tinged in places with green.

River Scene at Night.—A design suitable for a scene where dark and mysterious deeds have to be portrayed is given in Fig. 42. This scene is generally shown as a night effect, and the sky should be very dark and leaden in colour, with just a slight indication of very deep blue. The wharves and warehouses in the distance should be low in tone and only just discernible, and the water of a muddy-grey and sage-green tone. The masonry of the bridge should have a dirty and smoke-begrimed appearance, obtained with browns, greys, and ochres, with broad touches of green to indicate dampness, thus obtaining the effect of stonework when near the water. The sky, warehouses and wharves, river and muddy bankside should be first painted. Then the bridge, and, when all is dry, touches of detail can be put in, and the granite blocks of the bridge lined. The wing shown by Fig. 43 represents heavy wooden piles tipped with iron bands. The woodwork should be painted a greenish grey, and the ironwork black. The wharf or waterside warehouse, seen in the side wing (Fig. 44), should be a very dark grey touched up with black shadows; the brick embankment should be a dull heavy red with grey woodwork. The rope hanging on the pulley-block may be painted, or real rope can be used if desired.

Fig. 46.—Wing

Fig. 45.—Drawing-room Scene

Fig. 47.—Wing

Drawing-room Scene.—The scene shown by Fig. 45 is suitable for many different periods. It should be painted in white and gold, or cream and gold. If done in the latter, the scene should be treated to a flat tint of a light cream colour, and, when dry, do the mouldings and cornices in chrome, and touch up with a lighter yellow to give the effect of gilding. The carpet and curtains should be done in a bright blue or rich red. Figs. 46 and 47 show suitable side wings.

Practical Veneering

Veneers may now be readily obtained, and they are of two classes, known as "knife cut" and "saw cut," the latter being generally the thicker of the two. The veneers may be obtained in almost any kind of wood; but mahogany, satin-wood, walnut, rosewood, and boxwood are perhaps those most commonly used.

The Tools.—Few tools, other than those found in the wood-worker's kit, will be required for veneering. They consist of a veneering hammer, a saw, and a few suitable cauls. A veneering hammer (Fig. 1) consists of a wood head and handle, and a zinc blade which fits up into the head as shown, and is secured with a couple of screws, while the handle fits into the head, and is wedged in position. A suitable saw is shown by Fig. 2, and this also may be easily made. The blade of the saw should be about 6 in. or 7 in. long, and it is fitted to a wood handle as shown. The teeth should not be too large, and should not be given much set. The cauls are used to give a direct, even pressure, and in laying the veneers the cauls are heated and cramped over the veneers. The cauls will retain the heat better if made of zinc, which should be about $\frac{3}{16}$ in. thick; but if zinc cannot be readily obtained, some stout pieces of board could be used instead. For laying flat veneers the cauls should be perfectly flat and true; but in the case of a veneer being laid on a shaped surface, cauls of a similar shape must be prepared.

Laying the Veneer.—The surface on which the veneer is to be laid must, of course, be level and free from inequalities, and it will be found a good plan to brush over the surface with thin glue, working it well into the grain and allowing it to dry. The veneer must then be cut to shape, and for straight cuts the saw previously described and a straightedge should be used, while a fine fret-saw could be used for circular cuts.

When all the preliminary preparations for laying the veneer are complete, the caul which is to be used is placed in front of a fire and heated, and the cramps and other necessary appliances should be at hand. The surface should be slightly warmed, and the glue should be well boiled and fairly thin. Rapidly coat the surface with glue, and lay the veneer in position, holding it down by inserting a few brass pins round the edges. These should only be driven in half way; and they may then be turned over, care being taken not to embed them in the veneer. The surface of the veneer should then be covered with a piece of paper, and the caul, which should contain a good heat, should be quickly cramped in position over the veneer.

Cramping.—The method of cramping the cauls is shown by Fig. 3. It must be remembered that it is not the quantity of glue which leads towards good joints, but rather the expulsion of all the surplus, allowing only sufficient to remain to enter the grain of each surface and so bind them

Fig. 1.—Veneering Hammer

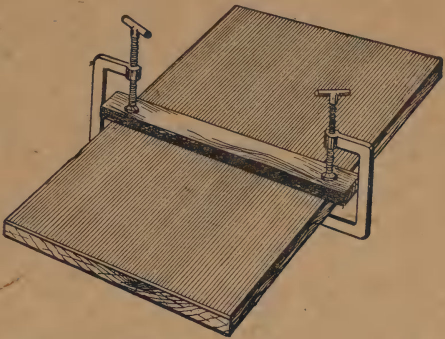


Fig. 3.—Method of Cramping Veneered Work

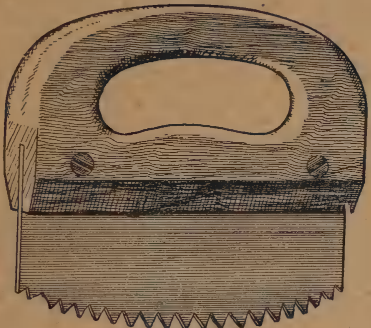


Fig. 2.—Veneer-cutting Saw

Fig. 4

Fig. 5

Fig. 6

Figs. 4 to 6.—Veneer Bandings

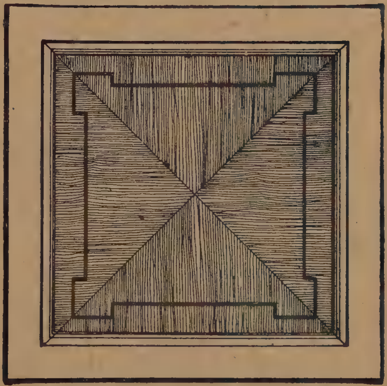


Fig. 7.—Door Panel Design

together. Systematic cramping is of the utmost importance, and a beginning should invariably be made in the middle. Cramps are then added on each side of those in the middle until the veneer is firmly cramped down, and the edges should be carefully watched to see that the surplus glue is being forced out. The work should now be allowed to stand for about twelve hours before removing the cramps. Having removed the cramps and caul, the pins which were used to fix the veneer round the edges may be removed, and the surface may be cleaned up, using a steel scraper and glasspaper.

Curved Work.—For a curved surface, the veneer may be cut and the surface glued in the usual way. The veneer is then placed in position, and the surface of the veneer is rapidly damped with hot water to render it more pliable. It may then be well rubbed down with the veneering hammer, working the hammer from the centre. In this method the use of cauls will not be necessary; but it might, perhaps, be found an advantage to pass a hot iron over the surface to heat the glue. Great attention should be paid to the edges of the veneer, and they should either be pinned or cramped down. This method may also be employed in the case of laying a small piece of veneer to a flat surface.

Blisters.—A common trouble in laying veneer is the formation of blisters, and these are caused either by the glue having become chilled, or by an air bubble. To remove a blister a small slit should be cut through the veneer with a very sharp chisel, and the surface of the veneer over the blister should be well damped. A hot flat-iron should be worked over the damped surface, and should it be necessary some fresh glue may be inserted through the slit. Carefully work all the surplus glue through the slit, and cramp down with a hot caul.

Veneer Inlaying.—Very effective inlaying is accomplished by means of veneers (see Figs. 4 to 9). Having set out the design full size on a piece of paper, the pieces of wood to make up the design are cut out (with fretsaw or in some other convenient way) to the shape required. The pieces are then fitted together to form the complete design, and then glued direct to the paper pattern, and glue is also worked in between the edges of the veneers. Another piece of paper is then glued over the top, and the whole is cramped between two pieces of board until the glue is dry. The inlay is then removed, and the piece of paper at the back on which the design was originally marked is stripped off. The inlay is then placed in position on the groundwork, and is scribed round the edges with a marking or scribing point. The wood in the ground work must next be cut away to a sufficient depth to receive the inlay, care being taken to work exactly to the scribed lines. The cutting is accomplished with chisels and gouges, and a router would also be found most useful in removing the surplus wood. The inlay is then glued in position, and cramped until the glue is set, when the surface is cleaned off by scraping and glass-papering.

Other inlay processes are described in a later volume.

Figs. 8 and 9.—Drawer Front Designs

How to do Leaded-glass Work

THE proper manipulation of the tools is in every art and craft one of the most potent factors in the production of good work, but in none is it more necessary than in that of lead glazing. The implements used are few and inexpensive. Many glaziers prefer to make their own, an easy matter in most instances.

Lifting Knife.—The first tool to be mentioned is the lifting knife, which is usually made from an old oyster opener. To do this, the blade near the point is heated in a bunsen or other flame, and slightly curved as shown at Fig. 1. It is the general practice to load with lead the end of the handle, which is used to drive in the tacks which will be mentioned later, a convenience for quick work, as it obviates changing over from the knife to the hammer. For loading, the end is shaped as shown in Fig. 2 by means of a rasp; then several thicknesses of strong brown paper are folded round and secured with string as in Fig. 3. The lead, having been melted in a ladle, is then poured to cover the extreme end to a depth of about $\frac{3}{8}$ in. and left to cool. In the hands of an able glazier this tool is made to perform a variety of functions, but its principal one is to assist in lifting the glass into the lead, or to open or press down the strip, as it is called, when the glass is fixed.

Larrikin.—Closely allied to the lifting knife in working is the larrikin, ladkin, or ladakin, as it is variously called. It is used for running down the groove of the lead to open it out the more easily to receive the glass, and also for pressing down the strip; still another use is to rub over uneven places and press them out, or to burnish off any rough or scratched surface. As a rule, it is made of box or some other hard wood, and is about 7 in. or 8 in. long by $1\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. thick, shaped at the ends as in Fig. 4.

Cutting Knife.—The cutting knife for the lead is of a special shape, and is generally made from a glazier's knife or from a table-knife cut down to a square edge, or shaped as shown in Fig. 5. The blade is left about 4 in. long by $1\frac{1}{4}$ in. wide, the edge being sharpened so that the knife can be used vertically like a chisel.

Soldering Bit.—The soldering bit is also of a special shape, although the ordinary article can be used. Fig. 6 shows the form usually adopted, the copper bit being a flattened square ending in a tapering pyramid-shaped piece called the nose. The wooden handle is loose, and is removed when the bit is put on the stove for a long heat. The nose is tinned when required by heating it, roughing over the face with an old file, and then rubbing with a little solder and solution of zinc chloride over a piece of tin; sometimes it is rubbed on a piece of sal-ammoniac or on a clean piece of cotton waste impregnated with spirits of salt.

Pliers.—The pliers used are of the shape shown in Fig. 8, the only point

to be noted being that new ones should be made to work easily, as otherwise a false grip may do damage.

Glass Cutters.—The diamond is a well-known tool which most glaziers possess. Many, however, prefer the wheel cutter, an inexpensive article which lasts a long time, and is not costly to replace. When worn down the wheel is easily re-sharpened by simply placing it on its bevel edge on a good oilstone and running it backwards and forwards a few times, then turning it over on the other side and repeating the action. Care should be taken that the wheel does not stick and that plenty of oil is used.

Other Requisites.—The tacks shown by Fig. 7 are known as shoemakers' lasting tacks; they should be about $1\frac{1}{4}$ in. long. Glaziers' benches take more than one form, sometimes being a substantial, well-built structure, and at others merely a piece of board on trestles. That such frail work as glass should be pieced together on such an unstable support as this is sometimes surprising to a novice; but the trestles and board have the advantage that they can be moved about quite easily as required for the purpose of getting all round the work.

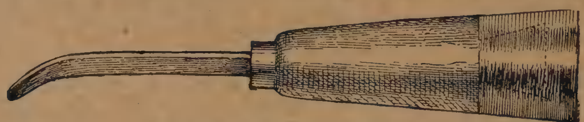


Fig. 1.—Lifting Knife

Fig. 7.—Tack

Fig. 5.—Cutting Knife

Fig. 2.—Shaped end of Lifting Knife

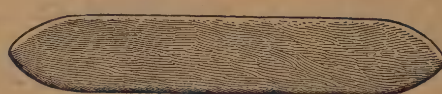


Fig. 4.—Larrikin

Fig. 3.—Pouring the Metal into Knife Handle

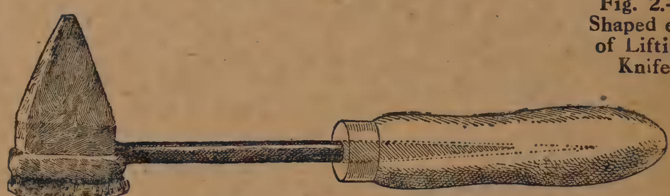


Fig. 6.—Soldering Bit

Glass.—This is, of course, the principal material, and its selection is therefore a matter of some importance. What is called antique glass is a well-known variety, the particular charm of which is much appreciated. It is blown into cylinders, which on reheating and rolling produce squares of about 2 ft. of uneven thickness and irregular surface. There is a reaminess which gives it a translucence, and renders it less transparent than ordinary glass, so that it becomes very luminous, and can be used very effectively in certain work. Another glass lately coming very much into favour is "Ambitty," which is made on the principle that glass kept at a red heat for a considerable time tends to a state known

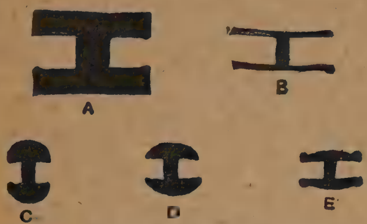


Fig. 9.—Sections of Lead for Glazing


Fig. 8.—Cutting Pliers

Fig. 10.—Setting out Panel


Fig. 11.—Allowance Made for Heart of Lead


Fig. 15.—Difficult Angle for Cutting

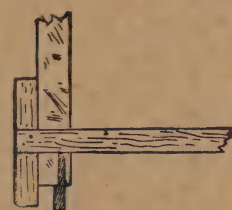


Fig. 13.—Using Cutting Gauge


Fig. 12.—Cutting Gauge


Fig. 18.—Parallel Joint


Fig. 19.—Angle Joint

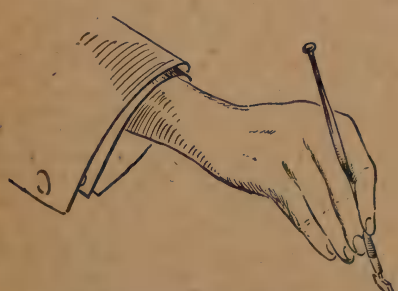


Fig. 14.—Method of Holding the Diamond

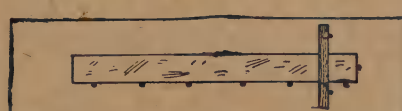


Fig. 16.—Cutting Board for Squares

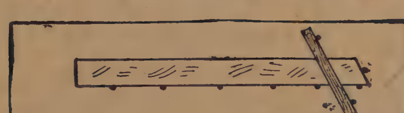


Fig. 17.—Cutting Board for Quarries

as "solid solution"; it crystallises out into definite crystal compounds. "Ambitty" is consequently of a sparkling appearance, transmitting much light, but not being transparent in itself.

Muffled glass is much used, and is fairly well known. It is a variety of antique, intermediate between antique as first described and venetian, and is not usually made in white glass.

A comparatively recent introduction is what is known to some people as "Early English," and to others as "Norman." It is made by blowing out to the shape of a large square pickle-jar, which is cut at the edges, leaving five slabs (four sides and bottom), which are much thicker in the centre than at the edges.

Fig. 20.—Leading Squares

Cathedral glass is probably familiar to everyone. It is a thin rolled glass of many delicate tints, nearly transparent, and used largely in cheap work. When made in stronger colours it is known as "pot metal." It has one side rough and the other smooth, and when leaded up should always have the latter facing outside, as dirt and dust are less likely to collect upon it. A more brilliant and transparent variety is known as double-rolled, and is preferable for some classes of work, having both sides smooth.

Plain sheet glass is too well known to need comment, but it should be of good quality for lead glazing.

Fluted glass, either plain or coloured, is very effective in borders, fillets, etc. "Sanded" is a ruby-coloured glass, which is sometimes used as a substitute for antique on account of the latter's expense. Ordinary ruby and one or two other colours are "flashed," the colouring being on one side of the glass only. Advantage is taken of this mode of colouring to form patterns by eating away part of the coloured surface with fluoric acid.

Roundels are much used in panels, and are very effective if judiciously placed. Bullions, or bull's-eyes, as they are familiarly known, can be often introduced with very pleasing effect. The best of them are made from crown glass; and these, whether used in plain or coloured glazing, produce charming results in designs that have been well thought out.

Lead.—The lead used is made in certain lengths and is of various widths and sections.

It is customary to use a lead of a wide and flat section on the outside of the lights, which allows of fixing in the groove or rebate. It is not well in very small work to use heavy leads, but some craftsmen possessing undoubted skill have a knack of producing quaint and pleasing effects by using rather thicker ones than usual.

In Fig. 9 is shown at A what is called "breaker" lead, which is made in lengths of about 6 ft. This can be drawn through a vice fitted with differently moulded cheeks to about five or six times its length to any section required. However, nearly all sections and patterns can be obtained ready drawn, and are invariably so bought. A flat lead as B is used for outside work, and is about ½ in. wide. C and D are other sections used, while E shows a popular pattern for inside work, it having a thread along its edges. The

sections B and E are the most useful for a beginner, who is advised to leave the other patterns alone at the start, and when better able to manipulate the tools to take up section C and then section D.

Working Drawing.—An attempt at practical work may now be made. Correct measurements are of the utmost importance. Never take the responsibility of working to sizes which are in the least doubtful or insufficiently checked. Disaster sooner or later is bound to come if this warning is not scrupulously observed. Therefore it is well to start by obtaining both sight and rebate sizes, and in every case of a shaped opening it is best to have a template of thin wood or cardboard. In some cases, where the opening is small, stiff brown paper will suffice.

The design is set out on continuous cartridge paper to the full size, according to the exact measurements; and in geometrical patterns, where a number of pieces of glass are required all of one shape and size, a small template of stiff paper is cut out carefully and correctly to the original design. These templates are used for placing on the glass, which is cut out to their shape until the required number is obtained; and by this means all are cut alike. A good way of ensuring accuracy is to take a piece of stiff tracing cloth and lay it upon the full-size drawing. Then trace along the insides of the leads with a pencil, and add an allowance all round for the depth of the opening in the lead.

A Simple Panel.—The panel shown in Fig. 10 (p. 355) is composed of plain squares, and is a simple job on which to make a start. The first thing to do is to cut the glass into what are called ranges, that is, lengths the width of the squares required. This necessitates a little forethought, allowance having to be made on measuring for the heart of the lead (see Fig. 11) and the number of squares into which each length will be divided. To test whether the first has been accurately accomplished, place a short piece of lead each side of a square, and refer to the drawing. If the centres of the cores come exactly over the lines drawn on the paper, all is well, and the worker can go ahead; but if the sizes are out, even by a little, a fresh range must be cut.

Cutting the Glass.—In cutting these ranges it is usual to use a gauge, which is merely a piece of wood of the shape shown by Fig. 12. By placing the notch against the edge of the glass, and the diamond or cutter firmly against the end of the gauge, and moving both along together, perfect uniformity is obtained. To cut these lengths into squares, measure with the gauge, and, bringing the T-square or straightedge up to it, as in Fig. 13, hold the T-square firmly, remove the gauge, and make a clean cut.

In Fig. 14 is shown the correct way of holding the diamond or cutter, ease and accuracy depending much on this. As a rule beginners press too heavily, causing splinters to be thrown up on each side. A good clean cut leaves behind a clear, silver-like line. To make a straight break, take the glass in both of the hands, and apply pressure as though the object were to bend the glass. With a curved piece, a knock or two with the tool on the under side, following along the cut, will generally separate the pieces. Awkward pieces, similar to Fig. 15, are best avoided as much as possible; when they must be cut, trouble generally arises, and the pliers may have to bite out—or "groze," as it is called—every bit.

In cutting out a large number of squares or quarries, as lozenge-shaped or diamond-shaped pieces are technically called, much assistance can be obtained from the adoption of a cutting board (see Figs. 16 and 17), the use of which saves time and ensures regularity.

Leading the Glass. — The full-size drawing should be placed flat on the bench and a lath nailed along the left-hand outer line. At right angles to this another should be nailed along the bottom line, as shown in Fig. 20 (p. 356). Next take the lengths of lead, and straighten them by placing one foot on one end and giving a sharp and strong upward pull at the other with a pair of pliers. Next take a length of wide lead to be used for the outside, and run the larrikin along the

groove to open the lead, and cut off an inch or two from the end, so as to remove any damaged portion there may be. Place this lead against the lath at the bottom, and keep it in position with a few tacks. Then do the same with another length of lead inside the left-hand lath, taking care to place the end of one lead into the other at the angle. Next take a length of narrow lead, and, cutting off the end, run into it a square of glass, and place into position, the narrow lead at the top having its end fixed in the outer lead, as in Fig. 19. Cut this off $\frac{1}{16}$ in. shorter than the glass, and tack in to keep in place. See that the fit is perfect, and that the smooth side of the glass (if there is any difference) is put to face what is the outside of the panel, a rule that must be observed with every piece. The second square is placed immediately above it, and the next above that in exactly the same way as the first, the tacks being removed as required; and as this is very soon after putting in, they should not be driven in very tight.


Fig. 21

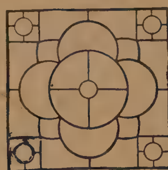


Fig. 22

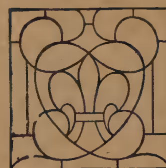


Fig. 23


Fig. 24

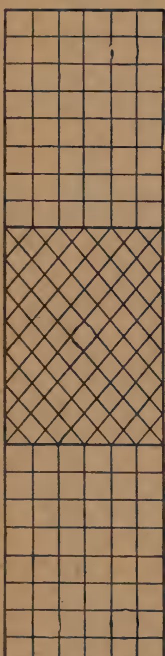


Fig. 25


Fig. 26


Fig. 27


Fig. 28

Figs. 21 to 28.—Ornamental Designs for Windows and Lights

The top piece in the first row having been placed, take a length of narrow lead, and fit it into the bottom broad lead. Then slip it over the sides of the squares, and cut off level with the top piece of

glass. Of course, the tacks have been removed to accomplish this and they should now be refixed to the right of the lead to keep it in place until the next row is fixed. The procedure for this is exactly the same, but the short leads of

Fig. 29.—Panel for Fire-screen

the last row are cut flush with the glass; and when the last piece of glass has been fixed in the right-hand corner, a length of wide lead is opened well out with the larrikin, and fitted up the right-hand side of the work, taking in the ends of the short leads. With a length of lath gently tapped with a mallet, drive this well on, and then nail down to the bench to keep in position while the top piece is fixed. This is done in a similar way, and when the lath is secured the work can be soldered. Before this is done, however, the larrikin should be gently pressed over every lead to make a firm and clean fitting of the leaf to the glass, and the outside edges accurately trued with a straightedge.

Soldering the Leads.—Although not really difficult, the soldering is probably the most awkward job for the beginner, and some practice is recommended before starting on any important work. For fluxing, resin, tallow, or "killed" spirits of salt are frequently used, but the former is difficult to clean off, and tallow is little better. Probably for this work fluxite is the quickest medium; it is clean and easy to handle. If resin is used it should be powdered, and a little placed on each joint. the tip of the solder just touching it and the hot bit applied. Great care must be taken not to melt the lead or to drop too great an abundance of solder in one place. Melt a blob of solder on to the bit. and spread it evenly, so as to make a good job. not allowing the hot bit to rest too long at one place for fear of melting the lead. Repeat the process at each joint.

When one side of the work has been soldered, remove the laths, and turn the panel over. There is a knack in doing this which is worth learning; it consists in drawing the panel forward until the middle rests on the edge of the bench, first balancing; then place the left hand underneath, and the right hand on the far edge; now quickly tip it on end, and give it a half-turn round. Then lay it half projecting over the edge of the bench, and with the left hand push it into position, placing it as before. Proceed to solder down the second side.

Fig. 30.—Leaded Light for Door, etc.

Filling-up.—When the leading and soldering are completed it will be found that, however well the lead fits round, there are various spaces between it and the glass which must be filled up. This

is done with a cement made by mixing together white-lead and lampblack with linseed oil. The best way of applying this is to place a little along the edges with a knife, and to rub it into the spaces with a hard brush, such as the pointed end of a

Figs. 31 and 32.—Two Leaded Lights for Doors, Windows, etc.

scrubbing brush. All superfluous cement needs to be cleaned off carefully.

Stanchion Bars.—If the panels are fairly large they will require strengthening by stanchion bars. These are fixed to the lights by means of copper wires about 3 in. or 4 in. long (No. 12 S.W.G.) soldered to the joints of the leads at two or three points along the part where it is proposed to place the bars. These are generally of iron, of a length and thickness to suit the strain the work may be expected to resist in use.

Leading-up in Sections.—In large lights it is sometimes necessary to lead-up in sections for convenience of working. In fastening these together, the lead that is to be above the other when all is fixed in the frame must overlap in order to keep the light water-tight. A method of doing this is shown in Fig. 18.

Some Designs.—Leaded windows and lights of an ornamental character are illustrated by Figs. 21 to 28; a fire-screen panel by Fig. 29; and three designs for general application by Figs. 30 to 32.

Spanners, and How to Use Them

The spanner is often regarded as the most insignificant member of a tool kit, but that idea is very far from the truth. From a casual observation of an engine, an experienced mechanic can form an opinion as to the class of spanners used in tightening up the nuts. The condition of the nuts and bolts is an index to the general character of the workmanship. The writer has in mind a steam engine supplied as new, the nuts on which showed evidence that they had frequently been removed and that ill-fitting spanners were used for tightening; upon investigation being made it was found that the engine had been in use for a number of years previously. In this case it was the condition of the nuts only that created the suspicion that the engine had been in use.

Using a Spanner.—The following instructions are only of value when the spanner jaws are of correct shape. There is a right and a wrong way of using a spanner. Fig. 1 shows the correct way, and Fig. 2 the incorrect way, the hand in each case being assumed to be moving downwards. Used as in Fig. 1 the pull is such that the spanner holds well to the nut. Used as in Fig. 2 the pull comes so nearly in line with the nut faces that the spanner is apt to slip off the nut unless kept pressed against it during the pull.

When the nut appears to be nearly tightened up, it is useless to expect that a series of jerky movements will complete the job; nothing is more erroneous. A steady pull must be given at the end of the spanner if a tight nut is desired. After the nut is apparently tightened, and has been left at rest for a period, the spanner can again be used, it being often found that the nut can be moved a little more. The use of a hammer on the spanner is deprecated. In the case of a spanner of ordinary length, the blow is ineffective, owing to the elasticity of the spanner, and there is but little, if any, result on the nut. Of course, if a very short spanner, say about 3 in. long, is used, a hammer blow will undoubtedly tend to tighten the nut, but the use of a hammer on a full-length spanner is a waste of time, and may possibly result in opening the jaws.

A spanner should not be used for several sizes of nuts, but one spanner should be kept for each size; and as nuts are now made exactly to size, this is an easy matter. Some mechanics use one spanner for a number of sizes, utilising a piece of mild steel, iron, or brass packing to make up the thickness; they also use a spanner in conjunction with a piece of round file for screwing up a pipe, but unless the spanner is one nearly worn out or of odd size, this method is not advised.

Designing Spanners.—The amateur who is interested in mechanical work may care to know how to design a spanner in a way that will ensure the best proportions.

The best angle for manipulating in the least space is one of 15° with the centre

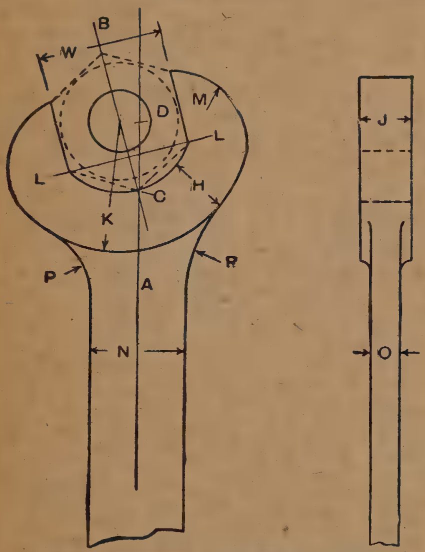
Fig. 1.—Correct Method of Using Spanner

line of handle, although many spanners are made having angles of 30° and 60°. In proceeding to design a spanner, lay off from the vertical centre line A (see Fig. 3) a line B, making an angle with it of 15°. From the point C thus formed, and with half the width of the nut across the corners, bisect the vertical line at D, from which point project a line at right angles to the vertical line; where it intersects line B is the centre of the nut or jaw; describe a circle (not shown), its diameter being the width of nut over the corners, which, with the same radius, divide into six parts, starting from the angled centre line B, and forming the sides of the nut and corresponding width of the jaws of the spanner. Then draw the line L L through the lower corners of the nut, and inscribe the inner circle of the nut, as indicated in the working diagram.

The next thing to decide is the width of metal at H, which is the most important part to be taken into consideration. A spanner may be taken as a lever, the short end of which is the width of the nut, and the point of intersection the fulcrum. The section at H being liable to a transverse strain, according to the ratio of leverage in the spanner's length and the power applied, the average transverse

Fig. 2.—Incorrect Method of Using Spanner

strength of wrought-iron being, say, about 3·6 tons per square inch, and taking one-tenth for the safe working strain, the section at this part should not be made to bear more than 800 lb. per square inch. In the figures given H = W × ·47, and the thickness J = W × ·4 (see Fig. 4). Having fixed the dimension H, describe the outside semicircle with radius K; the width at each side of the line L L = W × ·44. With radius M, equal to the length of flat on side of nut, and with the intersection



Figs. 3 and 4.—Designing Spanner

of line L L and the inner circle as centre, describe the arc, thus completing the form of jaw. The width of the shank N = W × ·825, the thickness O = W × ·225, the radius P = W × ·5 and the radius R = K.

The length is generally about nine times the width of the jaw or of the nut across the flats; but the length or leverage should be proportionate to the size of the nut for which it is to be used, and the number of threads in the screw. When it is too long an undue strain is put upon the bolt. Thus, in steam joints, such as the flanges of cylinder covers, the studs may be $1\frac{3}{8}$ in. in diameter, which equals 1 sq. in. in area at the bottom of the thread, and the screw will have six threads to the inch, or ·167 pitch. The corresponding width of nut is $2\frac{1}{16}$ in., and the length of the spanner is 18 in., the circle described by the hand at the end of the spanner being 113 in. To move the nut 1 in. along the screw, the hand must

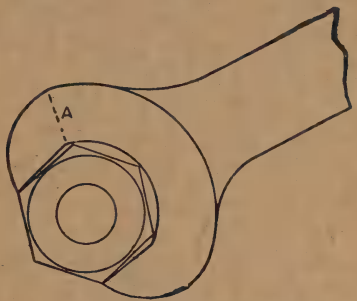


Fig. 5.—Bad-fitting Spanner

move 113 × 6 = 678 in.; and in order to exert a strain of 1 ton, in drawing the flange faces together, it is only necessary to put a pressure upon the end of the spanner of 2,240 lb. (= 1 ton) multiplied by ·167 (the pitch) and divided by 113 (the circle described by the hand) = 3·3 lb. But, as this is theoretical only, it is necessary in practice to multiply this by 4 to overcome friction and indirect strain, which gives 13·2 lb. as the applied pressure at the end of the spanner. Thus it will be seen that an ordinarily strong man, not aware of the power he may be exerting,

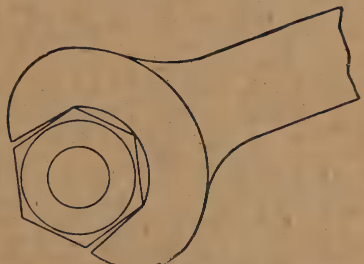


Fig. 6.—Bad-fitting Spanner

might easily twist off such a stud with a spanner of inordinate length.

Materials for Making Spanners.—Many cheap spanners are made of malleable iron, and these do not generally give satisfaction; they are often badly shaped,

have weak internal corners, they fit badly, and they frequently break. Mild steel is a suitable metal, inasmuch as it is an

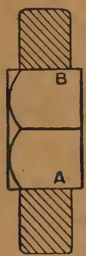
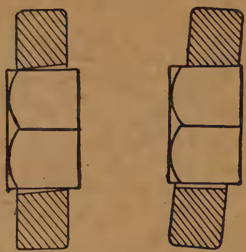


Fig. 7.—Good-fitting Spanner



Figs. 8 and 9.—Badly-shaped Spanner Jaws

easily filed material and can be case-hardened without difficulty. It is possible to use spanners for a number of years without their having previously been case-hardened, but after much use soft spanner jaws get badly worn, especially so when used on hardened nuts. The use of hardened nuts becomes more common daily, and it is, therefore, advisable to use a hardened spanner. Small spanners can be made from cast steel, but the question of expense prohibits its general use for large sizes.

Finishing the Spanner Jaws.—Assuming that the spanner has been forged roughly to shape, it remains to be finished by filing. The jaws must be filed perfectly parallel in two directions; a spanner will never give satisfaction unless these precautions are observed. If the spanner is finished as shown by Fig. 5, it will either break across the dotted line A, or be liable to spring over the edges of the nut. With jaws shaped as shown in Fig. 6, the tool will cause great trouble owing to its slipping off the nut, and consequently damaging the corners. It is, therefore, essential that the jaws must fit the nut as shown in Fig. 3. The importance of parallelism in the depth of the jaws is shown in Fig. 7, in which the upper and lower jaws of the spanner exactly fit the faces A and B of the nut. Fig. 8 shows the jaws of a spanner which are not filed at right angles to the faces; in use, such a spanner would be twisted out of shape and show a gap, as in Fig. 9. It will be seen that a considerable space exists between the nut and the spanner, and this is sufficient to make the spanner useless.

The nut-starting and nut-tightening device shown in use by Fig. 10 is simply a casting that fits snugly over the nut and is knocked round by means of hammer and punch as indicated. It is made in a series of sizes to fit the nuts in general use, and is occasionally of great advantage when manipulating a nut in a position where the employment of an ordinary spanner would be either awkward or impossible.

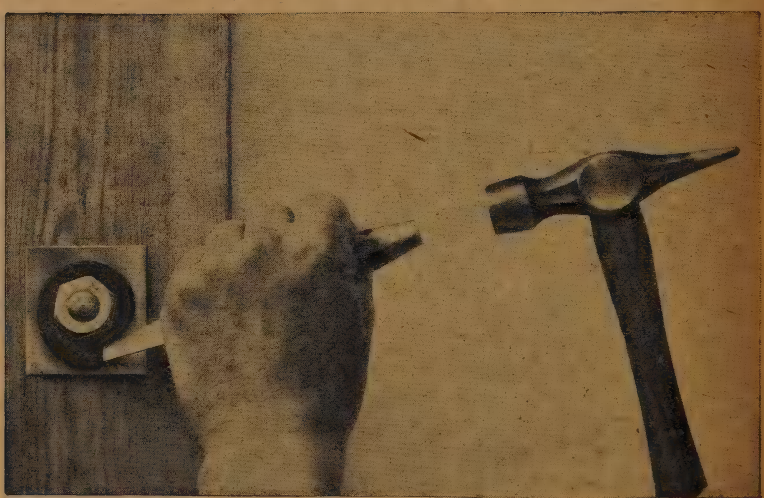


Fig. 10.—Using the "Ukantes" Nut-tightener

Cleaning, Re-gilding and Restoring Picture Frames

Cleaning English-gilt Frames.—Inasmuch as it is very easy to ruin gilt work by ignorant treatment, there is wisdom in making the first attempt at cleaning upon an English-gilt frame that is small both in overall dimensions and width of moulding. Remove the cord, place the frame face downwards on a thick layer of any soft material, and remove the paper from the back. Then withdraw the brads, taking care not to press on the glass or strain the frame in doing so; and after making sure that the rebate is clear of bits of old brads, take out the backboard and print or picture. Then draw the frame a little over the edge of the bench or table, insert the fingers of one hand under the glass, and raise it until it can be held with the other hand, the opposite side of the glass still resting in the frame. Now release the hand from under the frame and reinsert it under the glass, and so lift it clear of the frame. When replacing the glass, proceed in a similar way, lodging it in the rebate of the frame opposite to the left hand, taking hold of it with the right hand whilst putting the left hand under the frame to lower the glass into its proper position.

Next remove all dust from all parts of the frame with a cheap hog-hair brush, and with a similar brush wash off all dirt from the ornamental part of the gilded work, using a wash made by dissolving a teaspoonful of carbonate of soda in $\frac{1}{2}$ pt. of warm (not hot) water. With the same brush wash off this alkaline with clean cold water, holding the frame all the time in a slanting position to drain away the water. Let the pressure be light, the work be done as rapidly as possible, and do not go over it more than is absolutely necessary—not more than twice with the alkaline water, and that at one and the same time over the one place. One wash with the plain water, quickly applied after the alkaline wash has been finished with, is all that is necessary. Wipe the coloured edges of the frame, should there be any, and set aside in a warm place free from dust until quite dry, which will be in about twelve hours.

Protecting Old Gilt Work with Size.—If the gilding is not very old and is not too dirty, and the washing has been judiciously done, the frame will have been greatly brightened up, and it may be decided to defer the regilding until later. In this case, the gilt work should be protected by a coating of ormolu, or—an easier method—with plain size containing a little tincture of gamboge. For the second method, proceed as follows: A size made by steeping or stewing shredded plain parchment in clean water is used by the trade, but it is rarely stocked, and the same applies to the size in the form of a jelly, owing to its not keeping fresh for any length of time. Therefore, where best work is not under consideration, buy a cheap packet of size powder (sold at

paint shops and some hardware dealers'), and to ½ cupful of this add about 1 gill of boiling water, and stir until dissolved. Strain this through a piece of fine muslin and allow to get cold, when it should be a stiffish jelly. It should be warmed up again and kept warm, and a few drops of tincture of gamboge added, just enough to impart a yellowish colour. Shake up, and, while still warm, brush it over the gilded work with a soft, flat hog-hair brush. When applying the size, the pressure should be light and the brush not so heavily charged as to cause the size to lie in pools; also avoid, as much as possible, going over the same ground twice.

To make the gamboge tincture, dissolve as much gamboge as will lie on a sixpence in 3 parts of a teacupful of good spirits of wine. Always use the size warm, and not too hot.

If there is a flat or narrow gilt slip in the frame, it should be taken out at the same time as the glass. Lay it flat on the table or bench, wipe off the dust with a soft rag, and with a pad of cotton-wool damped with water and using slight pressure, wipe over once the slip, which should lie flat all the time. Then put away to dry. Do not go over the work twice, and use only cold clean water. When dry, coat with size, using a camel-hair brush, and go over it once only, as the gold comes off this flat work very readily.

Ormolu Size.—This is really a varnish, and is best bought ready made. It consists of a solution of 1 oz. of shellac and 1 oz. of elemi in 1 pt. of spirit of wine; or the elemi may be replaced with a tablespoonful of gamboge, increasing the shellac to 1½ oz.

Colouring Edges of Frame.—It now remains to colour the edges of the frame a light yellow, if they were so coloured before. (If they were gilt, they will have been treated as above.) The yellow colour is made by mixing together equal parts of yellow ochre and chrome yellow. Both are cheap pigments sold at oilshops; they must be in a dry state or ground up in water, not oil. Mix both together into a stiff paste with water, and thin down with size, which should be made as already explained; but use a stronger size made by mixing half as much again of the powder. Stir the colour well into the size whilst hot, leaving out the gamboge, and filter through coarse muslin; it should be fairly thick, so as to body well up, and if not thick enough let it gently evaporate down.

Cleaning Washable-gold Frames.—Frames, of Continental origin, finished in washable gold (a gold-colour alloy of base metals) should be cleaned in the same manner as described for English-gilt frames, and they will stand a little more washing. In some parts, particularly where the work has been burnished, the gold colour may have become bleached by the action of the light and atmosphere, and for this there is no satisfactory remedy. The frame could be coated afresh with Dutch metal by specialists in this kind of work, but after paying for the cost of the work done and carriage both ways, the price of a new frame will in all probability have been exceeded. The frame may be touched up a little by going over all the burnished work with gold paint, which will give the gold a matt appearance, but the paint will ultimately tarnish. Treat other portions of the frame that need it in the same way, using a camel-hair brush, and finish off by sizing, with the size and gamboge solution, that part of the frame which has not been covered with the gold paint. If, however, the burnished work has not suffered much, wipe it over with clean water, and when dry polish with a silk handkerchief.

Special Method of Cleaning Gilt Work.—The use of potassium cyanide gives excellent results, but this is a dangerous chemical to introduce into the home owing to its being extremely poisonous. The work, having been dusted, is washed over with water, to each pint of which has been added a piece of cyanide as large as a hazel nut. Use a fine sponge, do a small portion at a time, and quickly wash off with clean water applied by means of another sponge.

There is an alternative alkali to the carbonate of soda for cleaning gilt work.

Ammonia answers well, but there is always the risk of using it too strong; $\frac{1}{2}$ oz. of ammonia and 1 oz. of methylated spirit to 1 pt. of water is about right, the spirit assisting the liquid to dry quickly. In using this, the work should not be gone over more than once, and the ammonia water should be washed off quickly.

Cleaning Burnished Gilding.—Burnished work in good condition may be much improved by treatment with a folded wash-leather; the work is breathed upon and the wash-leather pushed over its surface, in so doing removing fly-marks, dirt, etc.

Gilding and Re-gilding.—There are three varieties of gilding in picture-frame work, and a good-class frame may exhibit all three. They are: (1) Oil gilding, the method that is generally employed for the modelled enrichments; (2) matt gilding, a dull gold finish employed for the flats, and always for the slip enclosing the picture; and (3) burnish gilding, used for the rounded portions in relief, and sometimes for small hollows. Fig. 1 (in the next column) shows a portion of a frame in which all three methods are introduced, but a simple style of frame may be finished throughout in one method. The order in which the three methods are executed in one frame are: first, the oil gilding; secondly, the matt; and, last of all, the burnished parts.

Gilder's Requisites.—Chief among the gilder's requisites is the cushion (Fig. 3), a flat, rectangular board covered on its upper surface with wash-leather, and padded with two or three thicknesses of flannel; part of it is surrounded by a screen of parchment to protect the leaf from a sudden puff of wind. Underneath the board is a loop for the insertion of the worker's thumb. On this cushion the gold leaf is cut to the required size, with a knife of the kind shown by Fig. 2, this having a long, straight blade and a smooth edge, and requiring to be kept perfectly free from grease, such as might be transmitted by the fingers, as otherwise, instead of cutting the gold leaf, it will pick it up. The tip (see Fig. 59, p. 35, Vol. I.) is a flat brush formed by gluing a row of camel hairs between two thicknesses of card. It is the means of transferring the gold leaf from the cushion to the frame, and is kept in condition for this work by being occasionally passed through the operator's hair. Besides these, two or three camel-hair mops and hog-hair brushes, the former for dabbing down the gold, etc., and the latter for applying the sizes, will be necessary (for illustrations, see p. 35, Vol. I.), also a pad of cotton-wool covered with soft muslin.

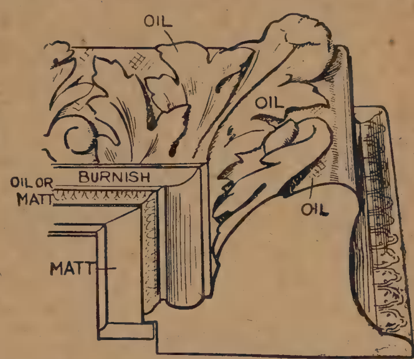


Fig. 1.—Part of Frame Gilt in Three Styles

The gold leaf, or "tip gold," is sold in books each containing twenty-five leaves, about 3 in. square.

Method of Re-gilding in Oil.—If a frame is to be re-gilded after being washed and dried as already directed, any cracks should be stopped up with a paste as stiff as dough, made by mixing whiting and orange chrome with strong, hot size. When this stopping is dry, coat the work as follows: Mix some whiting, with sufficient orange chrome, into a gold-coloured paste with water, place it in a cup, add hot size until of the consistency of thin paint, strain through muslin, and apply to the frame with a hog-hair brush while the colour is warm. Set aside to dry, and then give the frame a coat of clear

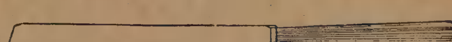


Fig. 2.—Gilder's Knife

size, or of size containing a little of the colour, and allow to dry.

Next procure a small tin of gilder's oil gold-size (which can be obtained ready for use) and well stir with a clean piece of wood. Then get a round hog-hair fitch (Fig. 25, p. 33, Vol. I.), about ½ in. in diameter, wash it in hot soapy water to free it from dust or grease, rinse in clean hot water, and dry it well. Then stir the gold-size with it, and, after freeing it from superfluous size, coat every part of the work which has to be gilded, giving an even layer and taking care to leave no part bare. A little pressure will be necessary to get into the bottoms and corners of the ornaments. Care is needed to ensure a perfectly sparing and even coating of the oil size, otherwise trouble will result. When this is done, isolate the frame from all source of dust in a warm room and allow about twelve hours to dry.

Fig. 3.—Gilder's Cushion and Knife in Use

It is important to know the exact time to lay the gold leaf, and for this reason it is better to attempt a small portion of the work, because, if the gold is laid on too soon, the oil seems to come through the gold, which will then present a dull, damp appearance; while if the size is too dry, the gold looks brassy and partly comes off when brushed. Therefore, at the end of twelve hours, lightly press the ball of the thumb on the work and withdraw it. If the "tack" is crisp and the surface of the work does not show any signs of disturbance, and there is no appearance of oil on the thumb, a little of the gold should be laid on with the tip pressed down very lightly with a tuft of cotton-wool covered with fine muslin. Then brush over with a soft hog-hair brush and note the effect. If the gold-size has been taken at the right time, the gold will appear bright, adhere well, and will not show the markings from the brush. If the gold is without lustre, smears, and shows the brush marks and clogs the brush, it has been put on much too soon, and the work should stand some hours longer and again be examined. When the right time for drying has been found, the time taken to dry, the temperature of the room, and the character of the "tack" should be carefully noted for future guidance.

Lifting and Cutting the Gold Leaf.—Now proceed to lift a leaf of gold on to the cushion, without it coming in contact with the hands. Insert the thumb of the left hand in the strap under the cushion, and with the knife get the leaf flat. This is done by scraping the flat of the knife a little in front of the leaf until it is slightly raised by the action of the air. Then slip the knife under it, and turn it over. Blow the leaf flat by a

gentle puff of air directed downwards on it; if the air is sent in an oblique direction the gold will fly about the room. Use up a leaf or two, trying to cut it in narrow strips without jagged edges. Pick up a little with the fingers, and note the effect on the gold of a person moving rapidly about the room or of a door being hurriedly opened. A little gold leaf wasted now may mean the saving of a lot at a later stage.

Applying Gold Leaf.—A good-sized sheet of white glazed paper should be placed under the work to be gilded. Then cut the gold into sizes to suit the work, and pull the hair of the tip between the flat hand and the hair of the worker's head so as to straighten it out and also make it take up the gold more readily. Lay the leaf on the work with the tip, seeing that each piece of leaf slightly overlaps the other, and press into closer contact with the cotton-wool. It will be found that some small pieces of gold will be needed to lay on places that have been missed. Cut up a leaf and make good these deficiencies; with the soft, flat hog-hair brush go over the work, and, where the tip could not get, use the brush to pick up a little gold from the cushion and brush it in.

When all is covered, brush the powdery gold on to the paper, and put it into a jar or wide-mouthed bottle, as this powder (called skewings) is used to brush in other work, thus saving leaf gold. Allow the frame to hang in a warm or dry place for a day or two to dry and harden, and finish off by coating with ormolu size.

Method of Burnish and Matt Gilding.—Flats, half-rounds, and other plain matt and burnished English-gilt work require much more careful handling, as in the majority of cases the gold leaf is put on with water or burnish gold-size and not oil gold-size.

The manner of cleaning burnish gilding has already been explained, but when it is to be re-gilt, proceed as follows: First wash it over with a clean sponge dipped in the warm alkaline solution until the gold comes off and leaves a dark, slate-coloured ground. Then wash with clean water, and stand aside to dry. When dry, rub it down lightly with No. 0 emery paper and dust off.

Get some gilder's burnishing size, gently warm it up, and make it workable with thin or weak size that has been warmed up and strained, and apply it with a camel-hair brush. This size should be of the consistency of thick paint. Lay it on evenly all over, and set aside to dry. Then rub down again, dust, and apply another coat. This should be sufficient, but an additional coating will perhaps be advisable. Stand aside to dry, and then rub carefully with the used portions of the paper previously employed, and remove all dust. Then wash the brush, and let it stand in a cup of clean cold water.

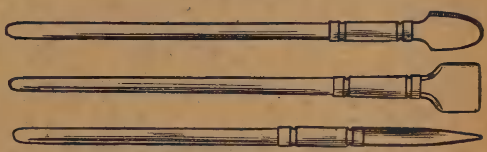


Fig. 4.—Burnishers

Next cut the gold to the required size, and wet the work thoroughly for about 12 in., having the top corner of the frame raised a little to run off the surplus water. While the water is floating, lay the gold. Wet another 4 in. or 5 in. down, lay on another piece of gold, and so on until one side is covered, blowing down any of the gold which is not flat on the work. If there are any parts not covered, cut a piece of the leaf, and damp the work with a smaller brush, not on the gold, but on the work it is intended to cover. When laying the leaf, let a little of the one piece overlap the previous one at the joint. Set aside to dry when the four sides are done, and lightly wipe over the work with a tuft of dry cotton-wool, and without any covering of muslin.

If any cracks appear, or if there is any part not properly covered, damp with the small brush and cover with the leaf, allowing all to dry before going farther. If one side of the frame is done first, any faults and the remedy will be seen.

Burnishers (Fig. 4, p. 369) are sold in different shapes for flats, rounds, hollows, etc., at different prices and material ranging from 2s. 6d. each. The tool should be held firmly, and with some

Fig. 5.—Damaged Corner of Frame

pressure be rubbed backwards and forwards at a fairly brisk rate, until the necessary polish is imparted. If the light is shaded by the open hand held over the work, it will be seen what progress is being made.

The matt portion of the work should now be finished off by sizing with the gamboge and warm size, taking care not to go over the work twice, and avoid touching the burnished part.

The gold-size when finished with should be put away, the brush taken out, washed and also put away. When the size has set, some clean cold water should be put over it, and a paper or cork used to keep out dust. Do not make more than is wanted at a time.

RESTORING DAMAGED PICTURE FRAMES

Notwithstanding the large variety of types of modern frames that have since been introduced, the old-fashioned gilt frame with modelled enrichments still holds its own, being regarded as the most suitable and artistic form of framing for an oil painting. The material of which these frames are made, although practically imperishable under ordinary conditions, is easily broken, and in moving about quickly becomes damaged. The repair of the modelled enrichments, however, is fairly easy to carry out, providing sufficient of the ornament is left from which to copy the missing parts. Good frames in a damaged condition can frequently be acquired for next to nothing, and they really make an excellent speculation for a man who is neat and can gild, for a good frame of this character can usually find a ready market.

In taking in hand a typical frame, the first thing to do, should it be necessary, is to bring the corners together by inserting on the slant a couple of wire nails, first boring holes for them The next matter is to supply all missing parts and glue them in. In nearly all cases the four

Fig. 6.—A Corner Fairly Complete

corners are alike, and this is why the making up becomes such a simple matter, for it is hardly likely that a section will be broken away in exactly the same place in all four corners. Probably one corner will be fairly complete, except perhaps for one or two minor details. The manner of

repair is to make a cast of a perfect part in plaster and then to take a "squeeze" in composition which is cut to fit the portion that is broken.

In the case of a frame that recently

Fig. 7.—Moulding a Corner

came under the writer's notice, all three corners had been badly knocked about, but one was fairly perfect. A typical damaged corner and one almost complete are shown by Figs. 5 and 6. The latter is made quite complete by supplying the missing part at A. A plaster mould of the opposite side of the corner B, where this particular detail happens to be complete, is made, following the instructions given in the chapter on "Casting in Plaster and Cement," elsewhere in these volumes, an exact reverse being the result. A piece of soft composition (compo.) pressed into this mould will, of course, take the shape, and is then trimmed with a knife, glued to the missing part, and allowed time to harden. If much damage has been done to the corners, it is best to restore one that is least damaged, as in this case, and then make a mould of the complete corner. To do this, first brush out the interstices with a small stiff brush to remove all the dust and dirt. Then give a thorough oiling with linseed oil, but be careful to remove all superfluous oil. It is by far the best plan to make a wall of clay round the part of which it is required to make a mould, to prevent the plaster running where it is not required; but when a very small piece only is required to be moulded this is not necessary. The plaster of paris is mixed up to about the consistency of cream to make a good hard mould; it is well beaten up, and then poured on that portion enclosed by the clay band. It is backed with a piece of tow steeped in plaster that will, in case of fracture, prevent the portions of the mould from coming apart. Fig. 7 shows the mould at this stage of the work. Allow about an hour to set, remove the clay band, and the mould should then lift off quite easily if the ornament was

Fig. 8.—Mould and a Squeeze from It

well oiled in the first instance. In Fig. 8, A is the mould of the corner shown by Fig. 6, while B shows a squeeze in compo. taken from a portion of the mould.

How to Make Picture-frame Compo.—This is a substance not unlike putty in appearance, and it may be bought

quite cheaply, or easily made at home as follows: Heat up some glue with a little water until liquefied, and add a little more than half the quantity of linseed oil and a little resin. Powder some whitening fine and add to the mixture to make a thick mass, which is well kneaded in the hands to remove all lumps, etc., until it is like modelling clay. The composition requires to be warmed and worked up before using, and during working it is kept in a jar stood in a pan of warm water.

Before taking impressions from the mould see that the compo. is well dried, or it will be liable to stick, and a perfect replica made impossible. About an hour in front of a warm fire will be found sufficient for drying.

To make a replica from the mould, press a piece of compo. well into the interstices where required, and then pull it out from one end carefully.

Compo. repairs are fixed to the frame with good hot glue, and are cut and adjusted to fit neatly, so that the joints are imperceptible.

Cutting Glass Bottles

THE principle on which a glass bottle may be cut (actually, cracked) when a diamond cannot be used, is the application to the cold glass of sudden heat, or of sudden cold to the hot glass.

For cutting a glass bottle, a small jet made by drawing out a glass tube, or the mouthpiece end of a clay tobacco pipe, will be suitable; connect this to the gas supply by means of a rubber tube. Stand the bottle on a table and fill it with water to the point where the bottle is to be cut, and make an ink mark around the bottle at the level of the water. Now empty the bottle, and with a triangular file make a deep cut on the lip of the bottle, and having lit the gas-jet, place it on the mark. After a few seconds remove the flame, and touch the part with a match stalk, wetted; a crack will form at once, or after two or three trials. Now place the flame in front of the crack and lead it down the neck of the bottle to the ink mark, then right round the bottle.

The following is a simple method of doing the work: Obtain a piece of $\frac{3}{8}$-in. round iron rod (less would do, but the $\frac{3}{8}$-in. will keep the heat longer), about 2 ft. long, and bend it at one end into circular form, making the eye of a size sufficient to slip down over the neck of the bottle to the point where it is to be cut. Place the iron in the fire, and while it is heating place the bottle on the hearth or table near to hand, together with a bucket about three parts full of cold water. Now take the red-hot iron in the right hand, and pass it down over the neck of the bottle, and press firmly, while with the left hand twist the bottle round for a few seconds to make sure that the iron touches all round. Then withdraw the iron and plunge the bottle, neck downwards, in the water, and the neck will drop off.

With practice, several bottles can be cut with one heating of the iron.

It sometimes happens that the bottle will crack quite successfully when dipped in the water, but the neck will not fall off; it will be found, though, that a slight tap with the iron will be sufficient to part it.

When the bottles are all cut, rub down the sharp edges on a stone, or with fine sand and water, or coarse emery and water, spread on a hard surface.

Ornamental Cement and Concrete Work

CEMENT work forms an excellent paving for porches, small greenhouses, garden walks, and similar places, and possesses almost the durability of stone paving, whilst it is much easier and safer to handle than stone. Besides its utility as a water-resisting paving, it becomes an invaluable material for steps and treaders, and by mixing it with sand and broken brick to form concrete the cost may be considerably reduced, while not impairing the durability in any degree.

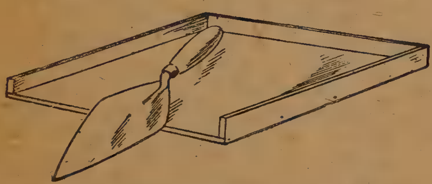


Fig. 1.—Trowel and Mixing Board

Making Steps.—For such purposes as making steps, the cement can be conveniently moulded in a wooden box, the inner measurement coinciding with the required size of the stone. The angles of the mould require to be true, otherwise it only needs to be roughly made, as slight irregularities may be easily removed from the cement surface by rubbing with a flat stone or iron scraper when hard. The joint of the box should preferably be screwed, so that it may be easily taken apart.

In filling the mould, the first thing is to provide for the face of the stone by mixing up sufficient neat cement to obtain a thickness of 1 in. to $1\frac{1}{2}$ in. In order to obtain the greatest possible degree of hardness, a small quantity of water only is added to this particular layer, the proportion of water being about one-third in volume. Also, the cement should be well beaten up, for the more that it is turned over before the settling begins the harder it becomes.

Fig. 1 shows the trowel and mixing-board, the latter being protected on three sides, with one side left open for convenience of working.

Fig. 2.—Levelling Off

The layer of pure cement is then backed with a mixture of cement and sand in equal proportions, and the remaining space is then filled in with a conglomerate of cement, sand, and broken brick, the different layers being put in as speedily as possible, so that one part does not get hard before another is applied. (For first-class concrete, the precautions given in the chapter entitled "Simple Bricklaying" should be observed; excellent propor-

tions are as follow: 1 pail of portland cement, 1 pail of clean, sharp sand, and 4 pails of broken brick or stone ballast.) The top is smoothed by drawing a straight-

Fig. 3.—Design in Inlaid Cement

edge across the top of the box to remove all the cement that is superfluous (see Fig. 2). A quarter of an hour is the normal time for cement to take its first set; but it does not get thoroughly hard for some days. The mould and its contents should therefore be put on one side, and left for two or three days to dry out completely, when the contents will be found to have shrunk, and will easily leave the mould. In the case of a good-size stone, this shrinkage should be allowed for in making the box.

Making Paving Flags.—The procedure for making a flat stone for a paved way is similar, a shallow box being made with the interior measurements slightly exceeding the size of the stone, so as to allow for shrinkage.

Colouring Cement.—One of the most useful characteristics of cement is that

Figs. 4 and 5.—Patterns for Inlaying

quite a lot of colouring matter may be added to it without seemingly injuring its lasting qualities. This allows the craftsman admirable opportunity for the production of simple decorative effects, by means of inlaying a cement of one colour into that of another. The pigments employed are the ordinary powder colours, and the brightest tints added to the cement become an artistic shade at once, by reason of the greyness of the material. It is a matter of some peculiarity, however, that some pigments may be added to the cement in far greater quantity than others. Indian red and yellow ochre, for instance, may be added in far greater bulk than ultramarine and ivory black without interfering with the setting in any way. A fair proportion, however, is 5 per cent. of dry colour.

Inlaid Effects.—A method by which patterns may be produced in different-coloured cements by inlaying will now

Fig. 6.—Design for Porch Paving in Cement

be described, the process being a most effective and durable one. Figs. 3, 4, 5, and 6 will give some idea of the class of pattern that is procurable. Fig. 3 is intended for a small porch or step; Figs. 4 and 5 would be suitable for repeating along a short pathway, or could be repeated on a greenhouse floor. Fig. 6 is a scheme for a square porch. As in the case of the work that has been described, cement inlay may be executed in position or in a mould. In the case of fair-size work the former is the better plan, while small surfaces can be conveniently inlaid in a shallow box mould.

Let it be supposed that it is required to inlay the pattern shown in Fig. 4. The first thing to do is to draw out the pattern full size on a sheet of drawing-paper. In

the case of two or three repeats, only one need be drawn; but the curves and lines of this one need to be accurately disposed to ensure success. Next transfer the pattern to a piece of wood about $1\frac{1}{4}$ in. thick, and saw out with a keyhole saw. Fig. 7 shows the wooden shape thus obtained. This is laid in the moulding-box, the background being then filled in with coloured cement, scraped flat and left to set; but not necessarily to harden. When firm the wood pattern is lifted out, and the space that was occupied by the wood is then filled in with cement of a contrasting shade. The whole is then left for some days to thoroughly harden, and

Fig. 7.—Wooden Pattern

Fig. 8.—Cement Workers' Tools

the surface made perfectly smooth with a metal scraper or stone.

The design in Fig. 6 is intended to be executed in cements of three colours, the procedure being similar to that described, although in this case it will be found more convenient to cut the wooden pattern in sections, which will not require to be joined, but merely laid in position in the moulding-box. It has been recommended to prepare the shape in stiff clay, and when only one repeat is required this is perhaps the simplest method.

Of course, the work offers great scope for artistic treatment in the disposition of the colours; but, broadly speaking, the two colours that have been mentioned are both suitable in most cases for large surfaces, while the more brilliant hues may be safely employed for smaller details. It is a good plan, however, to make a few experimental pats of coloured cement beforehand, to gauge the strength

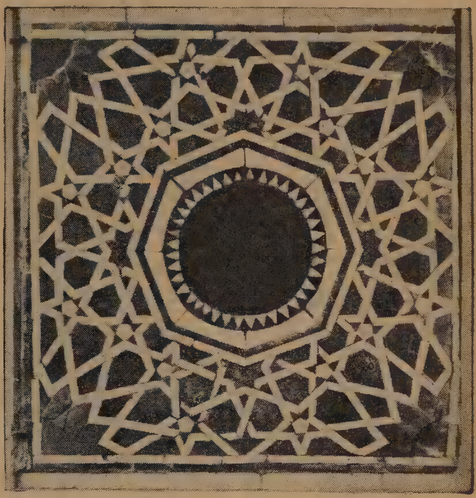


Fig. 9.—Example of Saracenic Mosaic

of the colours. A pattern that is not sufficiently telling may be brought out by outlining with a cement of a contrasting hue. This is performed by raking out with a pointed tool such as shown by A (Fig. 8) a line round the pattern to a depth of about $\frac{1}{2}$ in. or so, to receive a filling of cement. B in Fig. 8 shows another cement worker's tool of steel that

Fig. 10.—Example of Saracenic Mosaic

will be found useful in this respect, as well as for other purposes.

Cement Mosaic.—Yet another branch of cement work that is receiving attention at the present time is the making of

mosaics in this substance. For the home craftsman this process forms an admirable pastime, and presents little difficulty if the work can be extended over a few

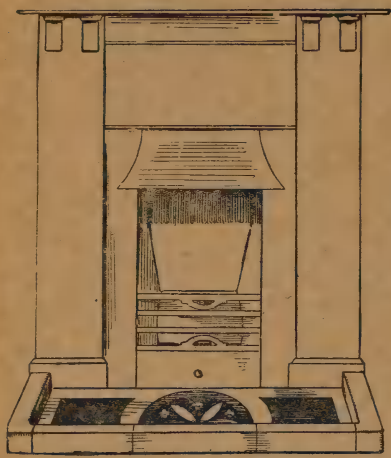


Fig. 11.—Fireplace with Cement Hearth and Curb

weeks, to allow time for settings, etc. Mosaic is such a beautiful means of decoration that the labour expended on it is well repaid for in the result. Figs. 9 and 10 show two very beautiful ancient examples of this class of work executed in fragments of marble. Fig. 9 would be simple enough for even a beginner to work, and the effect is such that one would find it difficult to improve on.

Cement Hearth and Curb.—Among the uses to which cement work might be very suitably put mention may be made of the hearth of a fireplace, of which Fig. 11 will give some idea of the effect produced, the curb also being of moulded cement, which would actually in cost be cheaper than a fender.

The method of working consists of first moulding several slabs of coloured cement in shallow box moulds, a depth of $\frac{3}{4}$ in. being sufficient in most cases. These are left to harden thoroughly, and are then broken up into pieces with a square hammer on an iron rest. These pieces need not necessarily be square; but if it is desired that they should be a particular shape, they can be trued on a grindstone or with a rasp. A great variety of hues is not necessary to make a work that is distinctly artistic. Three, or at the most four, different colours are usually sufficient.

Cases are used for "setting in" the work. These are very similar to the moulding-boxes already mentioned; but require to be well made, the bottom being nicely smoothed and strengthened by two narrow boards, set against the grain to prevent warping. Fig. 12 shows a case, and it will be seen that two of the sides are fixed, the two others being so jointed to these and pegged that they may be very easily removed.

Draw the design exactly the size of the work to be made, lay it in the case, and cover the drawing with thin glue to which a little nitric acid has been added, which will keep it moist. Then work the pattern by laying the pieces of coloured cement on the drawing round the outlines first, in rows, until they meet in the middle. A great amount of care will be requisite to obtain the best effect.

In many places it will be necessary to break pieces to fit, and often the pieces will not fit against each other exactly; but this will not matter. When completed pour over the back some thin cement, and then back up with coarser to bring the whole slab to about $1\frac{1}{2}$ in. thick. Keep in a dry room for two or

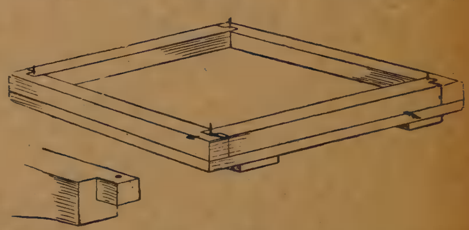


Fig. 12.—Case for Working Mosaic

three days, then remove from the case, and work the paper off the front, leaving the mosaic pattern exposed. Fill in all the interstices with a fine cement of an unobtrusive colour, polish with a stone, and the work is completed.

Figs. 13 to 15 give some patterns which an ordinary handyman would find little difficulty in executing, providing the requisite care is taken.

The dragon panel (Fig. 16) is something

Fig. 13

Fig. 14

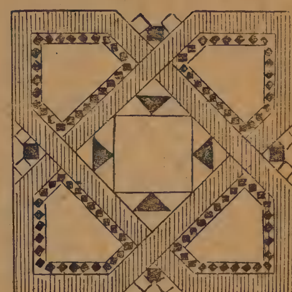


Fig. 15

Figs. 13 to 15.—Designs for Cement Mosaic

Fig. 16.—Dragon Panel in Mosaic

considerably more ambitious; but providing a good outline is made, and some attention paid to light and shade, no skill out of the ordinary would be necessary if heed is paid to the foregoing instructions. A good colour scheme would be deep browns and yellows for the dragon on a blue-green ground; but a few experiments with the actual colours should be made before proceeding with such a piece of work.

Garden Ornaments.—The making of garden ornaments in cement is quite within the scope of the average worker who has an hour to spare occasionally. A little ability for forming curves is necessary if one intends to ornament the

object, otherwise the work is straightforward. Figs. 17 and 18 show two plant-pots on pedestals of such design that offers no great difficulty in execution. Figs. 19 and 20 show the elevations with dimensions ; but, of course, these may be altered to meet requirements.

In making the ornament shown in Fig. 17, the construction of the cylindrical shaft should be first taken in hand. Join

Figs. 17 and 18.—Designs for Pedestal Plant-pots

together three boards 1 in. thick to form a square of 2 ft. 4 in. A piece of iron piping 3 ft. 2 in. long is passed through the centre of this, and made to project 2 in. at the other side. The projecting piece is inserted in a hole drilled in another board cramped on the working table, a little blacklead being introduced between the two boards, so that the upper one may revolve freely (see Fig. 21). Now build up all round the rod a mixture of fine cement concrete, the pieces of brick being no larger than a walnut. This rough work is continued to about 2 in. from the correct diameter of the shaft, it being usual to diminish the proportion of brick as the surface is approached.

Next cut a template consisting of a board with a straight piece cut out the length of the cylinder, this being fixed vertically with the baseboard at a distance of $5\frac{1}{2}$ in. from the centre (see Fig. 22). Then continue to lay on neat cement until it is of sufficient thickness, and true up by turning it against the template. The work should then be left for about twenty-four hours to harden somewhat, when any slight irregularities in the cylinder, such as scratches caused by lumps dragged over the surface, may be filled in and levelled with one of the steel tools. Then build up the cement base to a height of 1 ft. from the ground and a little within the wood base. This must be left for an hour or two to harden a little, a template being cut in the meantime to the shape

of the moulding. The template is cut in sheet zinc and mounted, to give strength, on a piece of wood, which is cut to the same shape, but sloping away from the cutting edge. These are nailed together, and a guide is fixed at right angles, and made rigid with a strut (see Fig. 23), a second guide being nailed or screwed on it to form a rebate. This rebate fits against the edge of the wood square at the bottom of the shaft, the template being drawnalong the cement to shape it, and when this is completed setaside to harden.

To form the plant-pot there will be required a box mould of wood, of the shape shown in one of the elevations (Figs. 19 and 20), the inside measurements corresponding with those shown, which will present no great difficulty. Great care is necessary in the setting out of the sloping sides. The wet cement is laid in the mould round the sides to a thickness of about 3½ in., also at the bottom; and after a day has elapsed the wood may be broken away and the cement faces smoothed up, the laying trowel (Fig. 24) being found particularly serviceable for this purpose.

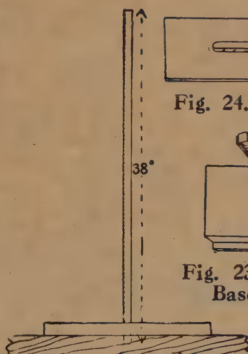


Fig. 21.—Turn-table for Working Cement

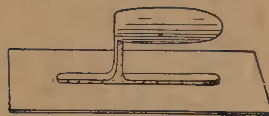


Fig. 24.—Laying Trowel

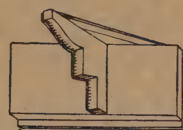


Fig. 23.—Template for Base of Pedestal

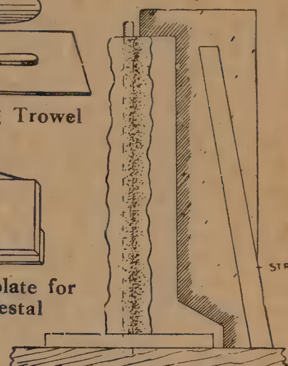
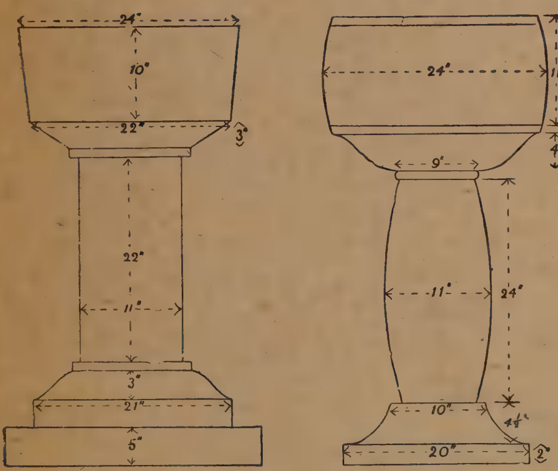


Fig. 22.—Method of Turning Shaft



Figs. 19 and 20.—Elevations of Plant-pots

The bottom of the pot and the top of the shaft must be perfectly level, a hole being drilled in the centre of the pot for the insertion of the projecting 2 in. of iron pipe. The small square moulding is added in cement at the bottom of the pot with the laying trowel, and is trued up with the help of a try-square.

This completes the plain form of the object, the ornament being now drawn out full size on paper, the ground of the design being cut away where possible to form a silhouette. This is laid on the surface of the cement, and traced round with a steel point. Use one of the tools illustrated in Fig. 8 to cut away the ground round the interlaced work, the sunken part being levelled with the tool shown at B.

A variety of effects may be produced merely by scratching away the cement, but corrections and additions may be made by applying fresh cement where required. If the shaft of the pedestal is stippled over with a little cement it will give an effect that will be rather better than a perfectly smooth surface.

The ornament shown in Fig. 18 is made on an exactly similar plan, with different shaped moulds, except that the pot in this instance is turned instead of being

made in a box mould. The hollowness is obtained by building the cement round a conveniently shaped earthenware vessel, which requires to be plentifully oiled to facilitate removal when the cement has set.

A great variety of designs for these and similar objects may be found among ancient works, and it only requires a little taste to turn these beautiful things to account in modern decoration. Fig. 25 shows a very early Christian font, the ornamentation of which would indeed be very suitable for the purpose in hand. If the worker possesses the ability to adapt, a great deal can be obtained from these early examples, which in many ways would be most difficult to improve upon. Fig. 26 gives an illustration of a piece of Celtic interlaced work, which would be particularly suitable for executing in cement in the manner described.

Fig. 25.—Early Christian Font

Fig. 26.—Example of Celtic Interlaced Cement

A finish giving a more artistic appearance than neat cement, and suggesting a natural stone and aged effect more appropriate for mediæval designs, is obtained by using, instead of the neat cement, a mixture of crushed stone, small pebbles, sand, and cement. If a colour scheme is desired, various coloured stones and sand are used. The grain of the finish can be varied by using various-sized crushed stone and pebbles.

For a rough finish, a mixture of 1 part of portland cement, 2 parts of yellow sand, and 2 parts of $\frac{3}{8}$-in. crushed stone; for medium grain, 1 part of cement, 2 parts of sand, and 2 parts of $\frac{1}{16}$ white pebbles, or 2 parts yellow pebbles; for a granite-grit surface, 1 part of portland cement, 2 parts of sand, and 2 parts of granite grit $\frac{1}{4}$-in. to $\frac{1}{8}$-in. particles; for a fine sandstone finish, 1 part of portland cement to 3 parts of yellow sand.

When the cement has got quite hard, the surface should be washed over with muriatic acid (common spirits of salt) diluted with one half water, which eats away the cement, exposing the stone. The surface is then washed with an alkaline solution to neutralize the acid; ordinary washing soda will do. Finally well scrub with water.

Concrete surfaces treated in this manner, after exposure to the atmosphere for a short time, assume an artistic, natural-stone effect, which is a pleasing contrast to the objectionable harsh appearance of neat cement.

The Fixing of Mirrors, Mantelboards, etc.

THE fixing up of overmantels and other mirrors is a matter that requires practical knowledge, as otherwise there is danger of their falling from the wall at a later date. A thoughtless, or inexperienced handyman may do serious damage in attempting to hang a mirror or heavy frame by driving nails into gas-pipes or water-pipes, or by cutting electric wires, in the course of plugging a wall. Before doing any work of this sort, a close examination should be made so as to be in a position to judge of the course of any pipes or wires. Obviously, to pierce the wall immediately above or below a lighting fixture is risky. If there is any doubt it is best to pierce first with a fine but blunt bradawl, and it will be easy to tell by the feel whether lead, or iron, or wood or brick is reached.

Nails simply knocked into the wall are the simplest means of fixing or hanging small light articles, but these are not always reliable. When nails do not hold well in walls, the cause is often said to be "bad walls" but that is chiefly for want of knowledge. When a nail is driven into a "lath and plaster" partition it goes in easily until it comes in contact with the lath, when it jumps back again, because the lath is springy, and has no proper backing. If the lath is pierced with a sharp bradawl, the nail can be inserted, but it will not hold very well. Often the nail goes between the laths, and shoots in suddenly up to the head, as shown by Fig. 1; it is scarcely held, and may be gently withdrawn by the fingers. In fixing anything of much weight to a "lath and plaster" partition, screws should be used, and they should pass right into the laths or, far preferably, into the wood framing.

In a brick wall a nail will hold moderately well for light purposes if the plaster is not too soft; but the nail should not be too long, and must not be further hammered should the point touch a hard brick (see A, Fig. 2). Some soft bricks and some kinds of poor concrete take nails fairly well. It is much better when the nail enters the mortar between the bricks; a longer nail may then be used (see B, Fig. 2).

For fixing anything such as a large mirror, a simple and quick way is to drive in holdfasts or wall-brackets, the latter being pieces of iron about $\frac{3}{4}$ in. wide, by $\frac{1}{4}$ in. thick, of the shape shown by Fig. 3. They are used in the same way as the holdfasts (Fig. 4), but these wedge in tightly between the bricks, and are stronger. Generally, two are sufficient below and one above the mirror frame, which is secured with screws. Both holdfasts and wall-brackets are a nuisance when removal becomes necessary, and property-owners naturally object to the damage to the walls, which their use—and especially their withdrawal—causes. Also, the irons have a poor appearance in a well-decorated and nicely-furnished room. In the case of an overmantel, it is easy to avoid their use, since the weight is taken entirely by the mantel-shelf, and it is only necessary to keep it from falling forward; but still it requires securely fixing at each side near

the top. For this and other purposes it is best to plug the wall, and to fix with "ear-plates," sometimes called "glass-plates."

Having decided the point for the plug the paper should be cut through with the sharp point of a knife on three sides of a small oblong, and the paper gently raised

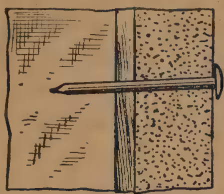


Fig. 1.—Nail in Lath and Plaster Partition

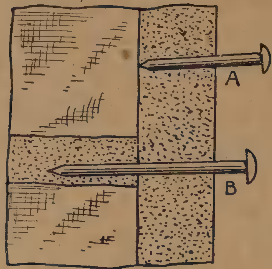


Fig. 2.—Nails in Brick Wall

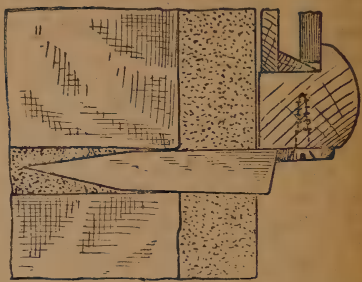


Fig. 4.—Mirror Fixed to Iron "Holdfast"

Fig. 6.—Wall Drill or Plugging Chisel

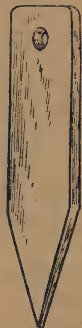


Fig. 3.—Iron "Wall Bracket"

Fig. 7.—Wood Plug

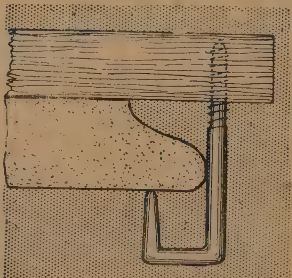


Fig. 8.—Mantelboard Fixed with Hooks

Fig. 5.—Drilling Hole in Wall

Many people do not like the idea of the wall being plugged, especially when it is newly papered or painted; but there is a particular way of doing the work which scarcely affects the appearance of the wall.

and pinned up (see Fig. 5). Whenever convenient it is cut on the lines of the pattern. To catch the dust when plugging, a "wall pocket" of paper is fixed with two pins, and the worker then pro-

ceeds to drill the hole. The "plugging chisel" or "wall drill," shown by Fig. 6, is used by striking repeatedly whilst being turned continually, until a hole is drilled in the brick or mortar of sufficient depth, usually from $1\frac{1}{2}$ in. to 3 in., which can be done in a few minutes. The plug may be of deal, similar in shape to Fig. 7; and it must fit the hole tightly. When the plug

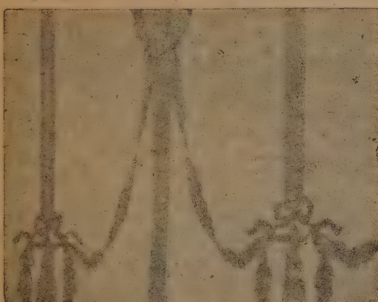
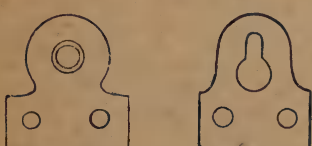


Fig 9.—Plugged Wall : Paper Re-fixed



Figs. 13 and 14.—Ear Plates

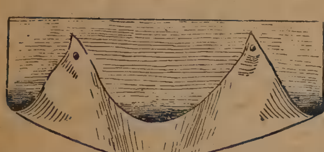


Fig. 16.—Alternative Form of Paper Pocket

Fig. 15.—Cruciform Plugging Chisel

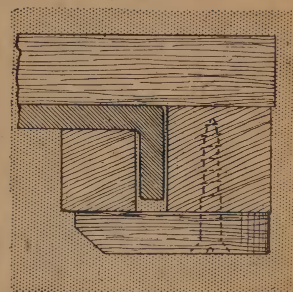


Fig. 11.—Fixing Clamped Board to Iron Mantelshelf

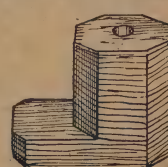


Fig. 10.—Turn-button

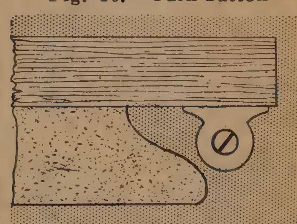


Fig. 12.—Mantelboard Fixed with Ear Plates

is driven in flush the hole is made in the centre for the nail or screw, and the paper fastened back over with a little tube cement applied on the tip of the finger, or with a touch of paste (see Fig. 9). In the case of a painted wall, the plug should be kept as small in diameter as possible, and the place may be touched up with oil paint. When a plugged wall is to be re-papered, it is well to put a fine nail in the plugs, standing up about $\frac{1}{4}$ in. so that they may be found again with ease. Should this precaution have been neglected a fine piercer or awl must be gently inserted until the difference in "feel" reveals the position of the plug.

Mantelboards often depend solely on the weight of the mirror to keep them in place, and are then extremely unsafe, especially if the board overhangs the shelf. A simple way to fix the board is shown by Fig. 8, a hook being put near each back corner and one or two at the front edge, the fringe being arranged to hide the hooks. Or wood "turn-buttons," as shown by Fig. 10, may be screwed on; but they take up more room at the ends

and front than do the hooks. Sometimes it is necessary to fix clamps across the ends of a mantelboard to prevent warping, and then a flat "turn-button" will do. Many mantelshelves are of cast-iron, in which case, whether hooks or buttons are used, blocks must be put underneath (see Fig. 11).

The above methods of fixing mantelboards suffice in many cases, but the possibility of the boards being pulled forward often exists, and to meet this contingency metal "ear-plates" may be screwed on the back edge of the board and nailed or screwed to wall plugs, as shown in Fig. 12.

There are times when it is not convenient to have the board any longer than the existing mantelshelf, and then the "ear-plate" must be used to show above the board. If it cannot be put out of sight, a brass-headed nail will look better in them than a screw, the same applying to the fixing of overmantels.

The "ear-plates" are useful for fixing and hanging many things about the house (Fig. 13 for fixing, and Fig. 14 for hanging); and they are to be had in different sizes, either in solid brass or in the cheaper "iron brassed."

Further Notes on Plugging Walls.—The plugging chisel used by some workers is of the shape shown by Fig 15. This needs to be correctly tempered, avoiding brittleness on the one hand and softness on the other. For a hole about $\frac{3}{8}$ in. in diameter, a drill $\frac{3}{8}$ in. at the cutting face is required, gradually drawn less, so as to give a clearance, and to allow the drill to work freely. Another suitable drill (for a $\frac{5}{8}$-in. hole) can be made of wrought steel, the stem being $\frac{1}{2}$ in. in diameter, and the point $\frac{3}{8}$ in. wide by $\frac{3}{16}$ in. thick. The point should be hard, but the butt end should be soft, so as not to chip when struck with the hammer. This drill is used by striking it smartly with the hammer, turning it slightly between the strokes; by its use holes can be made in the bricks in less time than it would take to find a joint. But should a joint be wanted, examine the doorway of the room, and notice if there are any nail marks on the door casing. If so, measure the height from the floor or ceiling, and transfer the measurement where the plug is to be fixed. If required higher or lower, count each course $3\frac{1}{2}$ in. Another way of finding the course is to examine the joints outside the window, and a pencil mark made on the sash can be transferred inside. To make certain, drive a medium-sized bradawl into the wall. If a brick is struck, try again in the same hole, but incline the bradawl up or down.

For heavy fixtures, the plugs should be square and slightly tapered. If the wood is split into squares, these can be easily and quickly finished by taking off a thin chip from each side with a chisel. Round plugs made with a dowel plate do not hold so well. To catch the dust, a pocket as illustrated in Fig. 5 should be used, or, instead, a piece of brown paper about 15 in. square could be pinned to the wall to serve the purpose (see Fig. 16).

The Rawlplug System.—The foregoing relates to the old-fashioned but still common methods of wall plugging, and it is only fair to state that the advent of the Rawlplug ought to make these methods obsolete, at any rate in most cases. The use of the Rawlplug has already been mentioned (see pages 167 and 168). Among its advantages, compared with the old-fashioned plugging, are speed, great strength, no mess while doing the job, and extraordinary neatness of the result. There is no objection at all to plugging a newly papered or painted wall, inasmuch as the fact that a plug has been used is not obvious. The Rawlplug chisel bears some resemblance to the cruciform plugging chisel shown in Fig. 15, and its use is exactly as described for that tool. Quite a small hole having been drilled very neatly in this way, a jute sleeve or plug of the proper diameter and length is simply slipped into the hole (not hammered in) and the screw, which must also be of a corresponding diameter, is then simply screwed in, the screwing action being very much the same as when inserting a screw into a tapped hole in metal.

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[redacted]

Jones
The amateur mechanic.